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U.S. PATENT OFFICE

A Boost for the American Merchant Marine

THE purchase of the fifteen million dollar plant of the New York Shipbuilding Company, Camden, N. J., by the American International Corporation and affiliated interests, which was ratified at a special meeting of the stockholders of the New York Shipbuilding Company on November 27, marks one of the most important steps in the present movement toward the upbuilding of the American merchant marine. The interests affiliated with the American International Corporation include the International Mercantile Marine Company, the Pacific Mail Steamship Company, the Grace Lines and other ocean transportation systems engaged in foreign trade. These interests comprise the largest steamship companies in the United States now engaged in foreign shipping, and the acquisition of one of the largest and best equipped shipyards in the country gives an exceptional opportunity for the co-ordination of shipbuilding and shipping operations which promises much for the future development of the American merchant marine.

The Day of Big Mergers at Hand

IN addition to the entrance of the American International Corporation into the shipbuilding field, negotiations of no less importance are in progress which may result in a merger of two of the largest shipyards in the country—the Newport News Shipbuilding and Dry Dock Company and the William Cramp & Sons Ship & Engine Building Company. Bearing in mind the extensive holdings of the Bethlehem Steel Company in the shipbuilding field, the numerous yards controlled by the American Shipbuilding Company on the Great Lakes and the shipbuilding and repair plants recently brought under the management of the Todd Shipbuilding Corporation, it is evident that the day of big mergers is at hand in the shipbuilding industry as elsewhere. That big combinations and centralized control and especially the interlocking of steel making, shipbuilding and shipping interests will prove beneficial to the shipbuilding industry from both financial and industrial standpoints cannot be doubted when the improvements and increased efficiency of production which invariably result are taken into account. If American shipbuilders are to make permanent the advantages which fate has literally thrust into their hands, the great resources of organization inherent in American methods of handling "big business" must be applied to the shipbuilding as well as to other industries.

Shipbuilding on the Great Lakes

THAT the prosperity in shipbuilding during the past year has not been confined solely to the coast yards is shown by the annual report of the American Shipbuilding Company of Cleveland recently issued. Due to the unprecedented demand for iron and steel products the season has been one of unusual activity for the Lake-carrying trade, and this has resulted in unusual demands upon the Lake shipbuilders, both for new tonnage and for a large amount of repair work. Further, the marked shortage of ocean tonnage has led shipbuilders on the Lakes, which hitherto have confined their operations almost wholly to the construction and repairing of Lake vessels, to undertake the building of ships for salt water service. A large number of Lake vessels have been sold and taken to the Atlantic coast to engage in coastwise and other deep sea service, so that the demand for Lake and sea-going vessels has steadily increased. The prospects for future business are in general better than ever before, although the prevailing high prices for shipbuilding materials and labor have limited the placing of contracts for Lake vessels to the actual necessities of shipping interests.

The Highest Powered Marine Diesel Engines

SO far as can be ascertained, the Diesel engines built by the Machinery Division of the New York Navy Yard for the naval collier *Maumee* are the highest powered marine Diesel engines installed on any vessel. The engines are of the two-cycle, single-acting type of 2,600 shaft horsepower each, built in accordance with original designs secured from the Machinen Fabrik Augsberg, Nurnberg, Germany, through the New London Ship & Engine Company, Groton, Conn. Each set of engines has six cylinders with a diameter of 25.2 inches and a stroke of 37.37 inches. The normal designed speed is 130 revolutions per minute.

It will be recalled that the hull of the collier *Maumee* was built at the Mare Island Navy Yard, San Francisco, Cal., and towed through the Panama Canal to the New York Navy Yard, a distance of 5,260 nautical miles, to receive her machinery. As designed the *Maumee* is a twin screw vessel of 14,500 tons displacement, 14 knots speed and 8,000 tons oil carrying capacity. The engines have now been installed on board the vessel, and on November 6 were given exhibition tests which were witnessed by many engineers. The vessel has since sailed for her sea trials and the performance of the engines at sea is awaited with much interest, as the opportunity is afforded for direct comparison with her sister ships fitted with reciprocating steam engines and turbo-electric propelling machinery.

Optimistic Outlook for Naval Architects

WHILE the annual meeting of the Society of Naval Architects and Marine Engineers, just held in New York, was not as well attended as was earnestly desired by those who have the best interests of the Society

at heart, nevertheless the Society gave every indication of a healthy growth, both in membership and in interest in the work before it. Throughout the meetings and the banquet which followed the professional sessions there was evident a most optimistic feeling for the future of the American shipbuilding industry and for the upbuildng of the American merchant marine. The conditions in the shipbuilding field throughout the world which have developed in the last two years, and which were so ably reviewed by the president of the Society in his annual address, give promise of a long-continded period of prosperity for American shipbuilders and a most hopeful situation as regards the growth of the American merchant marine.

Unfortunately, many of the shipbuilders were unable to attend the meetings, due to an important conference in Washington with the Navy Department regarding the contracts for the new naval construction authorized by the last Congress. Many others were also prevented from attending the meetings on account of the extraordinary rush of work which is now overwhelming naval architects, marine engineers and shipbuilders throughout the country. Due to the efforts of the secretary and other active members, however, over 100 new members were added to the Society during the meetings, and the Society will start the new year with a larger membership than ever before in its history. A glance at the list of new members will show that the Society has not only experienced a healthy growth in numbers, but that it has been materially strengthened by the high professional standing of the majority of the new members.

Millions of Dollars Wasted at Marine Terminals

For more than twenty-five years desultory efforts have been made to introduce freight-handling machinery in this country. During all these years the volume of freight has increased enormously; wages have gone up two or threefold, and the congestion at railway and marine terminals has become appalling, and yet nothing is done.

In the report of the Interstate Commerce Commission, published in 1912, it was shown that 900,000,000 tons of miscellaneous freight were handled during the previous year by the railroads of the United States. Leading terminal engineers who have thoroughly studied into the subject make the positive statement that from ten to twenty cents (0/5 to 0/10) a ton can be saved by handling freight at terminals with efficient mechanical appliances.

Here, then, is one direction in which the railroads of the country can save somewhere between $80,000,000 to $160,000,000 (£16,400,000 to £32,800,000) per year. As all freight is handled twice—once at the receiving end and again at the end of final delivery—the possibilities in saving would be about double these figures. And yet there is not one single railway freight station in the United States that is properly equipped with freight-handling machinery.

In the marine field it is estimated that 300,000,000 tons of miscellaneous freight are handled at marine terminals every year. As the conditions are practically the same in this field as in the railroad field, so far as economy in handling freight is concerned, there is a possible saving of from $30,000,000 to $60,000,000 (£6,150,000 to £12,300,000) annually. As this freight has to be received and delivered at marine terminals, the same as at railway terminals, the potential saving is twice the above amounts. And yet there is not a single marine terminal in any one of the hundreds of ports in the 5,000 miles of sea coast in the United States properly equipped with freight-handling machinery.

Over against this appalling situation is Hamburg, Germany, with about 700 traveling quay cranes, 200 or more winches and cranes in and on warehouses and a dozen or more heavy stationary cranes. The water front in Rouen, France, was increased from a capacity of 483 tons per linear yard to 1,121 tons by the introduction of machinery; in Marseilles the increase was from 665 tons per linear yard to 1,694 tons. On the 4,000 miles or so of Mississippi River navigable waters there is not a single landing properly equipped with freight-handling machinery, while on the river Rhine, with only 355 miles of navigable water, are 65 or more harbors with considerably over 400 warehouses mechanically equipped for handling freight, and 600 or more cranes and other appliances.

The railroad can make a possible saving of from $150,000,000 to $250,000,000 (£30,800,000 to £51,250,000) every year by using the proper kind of mechanical appliances to handle their freight, and the steamship and steamboat companies can save from $50,000,000 to $100,000,000 (£10,250,000 to £20,500,000) every year. In other words, our transportation companies are wasting between $200,000,000 and $350,000,000 (£41,000,000 and £71,750,000) of their stockholders' money every year by not installing efficient freight-handling appliances.

Any attempt on a large scale to bring about a change in the United States and introduce freight-handling machinery will be prohibitive in cost unless undertaken in a most comprehensive manner.

The men who have the handling of freight at railway and marine terminals have in nearly all instances grown up from the ranks. They are men of limited ideas and who cannot be persuaded to change from antiquated methods. Politics have a great deal to do with preventing a change, because in cases where hundreds of men are employed each one represents a vote. Boards of directors and others who have the handling of money hesitate to introduce new methods unless it is supported by the men who have the work in hand.

Scope of American Bureau of Shipping Widened by Acquisition of Great Lakes Register and Affiliation with British Corporation

One of the most important and far-reaching steps in the reorganization of the American Bureau of Shipping was outlined by Stevenson Taylor, president of the Bureau, at the annual banquet of the Society of Naval Architects and Marine Engineers, held at the Waldorf-Astoria Hotel on November 17, when he announced that the Great Lakes Register, which is affiliated with the Bureau Veritas for the survey and classification of vessels built on the Great Lakes for lake or ocean service, will henceforth be known as the Great Lakes Department of the American Bureau of Shipping, and furthermore, that an agreement had been entered into by the American Bureau of Shipping and the British Corporation for the survey and registry of shipping whereby these two societies will hereafter represent the same interests in their respective countries.

Mr. Taylor, who is president of the Society of Naval Architects and Marine Engineers, presided at the annual banquet of the society, and in his address described the new developments in the American Bureau of Shipping as follows:

"Thanks to the efforts of Judge Harvey D. Goulder and the interested patriotic vessel owners of the Great Lakes,

the *Great Lakes Register,* so well and favorably known for its work on the Great Lakes, has joined the American Bureau of Shipping and will hereafter be known as the Great Lakes Department of the Bureau, with Horatio N. Herriman the manager, and his corps of surveyors and assistants just as they have been, serving faithfully in the future as they have in the past. Hereafter, therefore, the judgment and experience of both corporations will be in unison to make classifications and surveys on the Great Lakes of the best character entitled to the confidence of all concerned in that important service.

"Believing that for trans-oceanic service all matters pertaining to construction should be governed by international regulations, the United States asked for an international conference on the subject of safety of life at sea. Such a conference was called to meet in London in November, 1913. This conference was attended by delegates from nearly every maritime nation in the world, and those appointed by the United States performed royal service in behalf of the cause, assisting materially in determining the convention, which was finally adopted and signed unanimously by the delegates from all nations. That it failed to be formally approved is another story not necessary for us to discuss at this time. Suffice it to say, the principle for which the conference was called remains the same to-day as in 1913, namely, that the construction of ships for trans-oceanic service should be so determined that in truth it shall be international.

"The American Bureau of Shipping fully realizes this need. It recognizes the valuable work done by other countries and their classification societies. It is therefore a pleasure to announce that in the Great Lakes service the arrangement made years ago between the Great Lakes Register and the admirable Bureau Veritas will be continued and probably extended.

"More, the American Bureau of Shipping determined that in such matters its action should be as near international as it could be made, and that as quickly as possible. For this purpose it sent Chief Surveyor McClelland abroad and there has been received cable advices that the American Bureau is at agreement with the British Corporation for the survey and registry of shipping, an agreement which gives the Bureau the full advantage of the practical experience and technical knowledge of that most progressive society, which during its twenty-six years has been recognized as leading the development of shipbuilding.

"The new rules of the Bureau will be based on the revised rules of the Corporation, and they will embody the most modern systems of building, with such scientific, accurate methods and such flexibility of application as will make them peculiarly adaptable to American ideals.

"The joint arrangement is particularly satisfactory because it ensures harmonious action and an interchange of ideas advantageous to owners and builders on both sides of the Atlantic without interfering with the independence and national character of either society.

"The arrangement immediately removes all difficulties in regard to international load lines for American classed ships, and will be of great advantage in helping our legislation when load lines are adopted here, as they must be.

"The Bureau will act for the corporation in America and vice versa. The classifications will be in effect interchangeable. Dual classifications will be obtainable at a little more than cost of single classification. Surely, development on such lines will be real international classification in its best form. Owners will now fully realize that no longer need they feel it to be necessary to have the classification of any particular foreign society to obtain full insurance here or abroad."

Lloyd's Annual Report

In few industries has the effect of the war been more widespread and far-reaching than in the domain of shipping. The disappearance from the high seas of the merchant fleets of Germany and Austria-Hungary, and the continued losses of allied and neutral shipping, combined with the enormous demands which the war has made upon the available tonnage, produced a shortage which has stimulated the building of ships in every country free to engage in ship construction. In the United Kingdom merchant shipbuilding is still seriously restricted by the necessity for the production of war vessels of various kinds; and, although there has recently been some acceleration in the rate of progress in the construction of vessels, the output remains far below that of normal times. In neutral countries, and particularly in the United States, every effort has been, and is being, made, by means of the extension of existing plants and the creation of new establishments, to cope with the increasing demand for tonnage. That a large measure of success has attended these efforts is evident from the fact that there is now being built under the inspection of Lloyd's Register of Shipping, with a view to classification, a larger amount of shipping than has ever been recorded in the history of the society, namely—620 vessels of 2,282,709 tons.

During the year under review the Lloyd's committee passed the plans of 742 vessels, representing 2,375,590 tons of shipping, to be built under the society's survey with a view to classification in Lloyd's Register, as compared with plans of 733 vessels, of 1,715,500 tons, for the previous twelve months. The committee assigned classes to 362 new vessels, of 790,209 tons, of which 356 were steamers, or motor vessels, of a tonnage of 789,688, and 6 were sailing vessels, of 521 tons. Of the total, 414,462 tons, or about 52½ percent, were built for the British Empire (United Kingdom 397,852 tons, Dominions 16,605 tons), and 375,747 tons, or about 47½ percent, for other countries.

American Committee Formed

To cope with the great development of the shipbuilding industry in America, an American committee of Lloyd's Register of Shipping has been established in New York, composed of leading underwriters, shipowners, shipbuilders and engineers, under the chairmanship of Mr. Alfred Gilbert Smith, president of the New York and Cuba Mail Steamship Company.

Among the most important changes in the society's staff in America during the year were the retirement of Mr. J. H. Mancor, for many years principal surveyor for the United States and Canada, and the resignation of Mr. Robert Haig, principal surveyor at Philadelphia, who has been elected president of the Robert Wetherill Engineering Company, Philadelphia, and a director of the newly formed Sun Shipbuilding Company. Mr. James French, principal surveyor at Glasgow, was appointed chief surveyor for the United States and Canada and technical adviser to the American committee; Mr. H. J. Cox, of the chief ship surveyor's staff in London, was appointed as assistant to Mr. French; Mr. E. M. Salmon, of the chief engineer surveyor's staff, was appointed principal engineer surveyor at New York; Mr. R. P. Hutchinson was appointed secretary to the American committee, and Mr. O. Narbeth, senior ship surveyor at Philadelphia, succeeding Mr. Haig as principal surveyor at that port.

Load Line Committee

The load line committee, in its report, points out that the means of closing openings is of vital importance, and proposes rules for machinery casings and for openings in

weather decks and sides of vessels, which are considered to be a necessary amplification of the present regulations. It is recommended that these particular proposals should be incorporated in the existing Rules for Freeboard.

The new freeboard rules proposed by the load line committee, which were framed with an endeavor to secure accuracy, simplicity and directness of application, make two main departures from present regulations with the object of providing, first, a means of assessing the freeboard allowance to be given for superstructures in a manner which will be equitable for all types of vessels, and, second, a standard of strength which could be applied internationally to ascertain whether the strength of a vessel is sufficient for the geometric draft which could otherwise be assigned.

During the year 1915-16 freeboards were assigned to 309 vessels, which bring the total number of assignments by the committee of Lloyd's Register under the Merchant Shipping Act, 1894, up to 17,949.

Types of Vessels Classed

The tonnage classed by the society during the year includes 32 vessels of 156,975 tons, built upon the Isherwood system of longitudinal framing. Up to date there have been built, or are in course of construction upon this system, to the society's classification, over 470 of these vessels, totaling 2,650,000 tons.

The number of vessels intended to carry oil bulk which have been classed by the society during the year under review is 14, of 77,167 tons. The total number of such vessels at present classed in Lloyd's Register Book is 301, of 1,380,235 tons gross. Vessels fitted for burning oil fuel holding classes assigned by the committee number 269, of 1,259,714 tons.

Owing to the increasing demands made for oil in this country many proposals to supplement the supply by converting ordinary cargo steamers into oil carriers have been dealt with by the committee. The society's classification has been assigned to vessels in which the oil is carried in large circular tanks built into the holds, and arrangements have been approved which will admit of fuel oil with a high flash point being carried in the double bottoms of cargo vessels, provided the construction is suitable for the purpose.

Revival of Wood Shipbuilding in America

Since the beginning of 1916 Lloyd's committee has considered proposals for the construction of several vessels to be built of wood, ranging from 100 feet to over 300 feet in length, the dimensions generally being similar to those of the four, five and six masted schooners built in the United States, the largest of which are 320 feet in length and 50 feet in breadth. It is proposed to build several of these wooden vessels on the Pacific Coast for use in the lumber trade to Australia. Steel reinforcements are introduced in the larger vessels at the keel and gunwale, and at the various decks, in order to give the necessary longitudinal strength to the structure. Plans have also been approved by the committee for several wooden vessels to be built on the Florida coast. In addition to the sail power, the vessels are fitted with single or twin screw oil engines for auxiliary use when necessary, donkey boilers being supplied for working windlasses and winches. Some of the larger boats will, however, be propelled by steam power alone.

Increasing Use of Geared Turbines

The increasing use of geared steam turbines in marine engineering is worthy of note. Nine vessels have been built to the society's classification during the past year, in which steam turbines have been fitted, three of these having Parsons geared turbines, and six having Curtis geared turbines.

At the present time there are 52 vessels in course of construction, with a view to being classed by Lloyd's, in which geared turbines will be fitted, viz.: 25 with Parsons single geared turbines and 27 with Curtis double reduction geared turbines.

Turbo-Electric Ship Propulsion

In the United Kingdom two vessels are being built to the society's classification in which the Ljungstrom turbo-electric propelling plant will be fitted, one a single-screw vessel, in which the power will be 1,500 shaft horsepower, and the second a twin-screw vessel with a total shaft horsepower of 5,400.

In the Ljungstrom turbine there are no stationary blades, the steam passes across two sets of blades which revolve at equal speed in opposite directions, so that the effect is similar to that which would occur with one set of blades stationary and the other set moving at twice the velocity. Each half of the turbine is directly coupled to its own alternator, producing a three-phase current of about 50 alternations per second with a voltage of about 800. The alternators of each set are electrically locked, ensuring exactly equal speed, and consequently equal power, on each rotating half of the turbine. In each vessel there will be two turbo alternator sets, so that the stoppage of one will not disable the vessel.

The two alternators of each set work in parallel. They have each only one pair of poles. They supply current to two motors each having five pairs of poles, which will therefore rotate at one-fifth the speed of the turbines. These motors are connected to pinions with spiral teeth which gear in the ordinary manner with a large gear wheel secured to the screw shaft. The combination of electrical and mechanical reduction gear will enable a speed of turbine of 3,600 revolutions per minute to rotate the screw at 76 revolutions per minute. The reversing of the screw is effected by the electrical motor, the steam turbines always running in one direction. Reduction of speed is effected down to about 80 percent of the full speed by varying the steam supply to the turbine. For slower speeds the regulation is effected by interposing resistances in the circuit.

Internal Combustion Engines

During the year under review seven vessels classed by Lloyd's have been fitted with Diesel engines. Three of these were built by Messrs. Harland & Wolff, Ltd., and engined by Messers. Burmeister & Wain, Glasgow, and the remainder were built and engined by Messrs. Burmeister & Wain, Copenhagen.

There are now 46 vessels holding the society's classification which are fitted with engines of this type, and, in addition, there are at present in course of construction under the society's survey over 30 sets of these engines. Twelve of the 46 vessels are equipped with "Werkspoor" four-cycle Diesel engines.

In addition to the foregoing, several vessels have been fitted with oil engines of other than the Diesel type, among which may be mentioned 11 fitted with hot-bulb engines made by Messrs. J. & C. G. Bolinder's Mekaniske Verkstads Aktiebolag, of Stockholm, and this type of engine is to be fitted in more than 30 vessels which are being built under the society's inspection.

Association of British Marine Oil Engine Manufacturers

During the year an association was formed by the British Marine Oil Engine Manufacturers for the promotion of the industry by the mutual interchange of ex-

perience, for standardizing designs as far as practicable and for carrying out such investigations and research work as may be necessary for the proper development of this type of machinery.

The association elected Mr. Milton, Lloyd's chief engineer surveyor, to act as chairman during the initiatory stages, and on the formation of the association Mr. Milton was nominated as an honorary member of the association.

Refrigerated Cargoes and Cold Stores

The number of vessels holding the society's certificate in respect of refrigerating machinery (Lloyd's RMC) is now 174, with a total insulated cargo-carrying capacity of about 37,500,000 cubic feet. The society's surveyors have held 1,017 surveys at loading and discharging ports on these vessels during the past twelve months.

The work of inspecting cold stores in various parts of the country is being continued, as is also the inspection of insulated barges trading on the River Thames.

Steel Testing

During the year 976,801 tons of ship and boiler steel were tested by the society's surveyors at home and abroad.

At the end of June there were 103 steel manufacturing firms in the United Kingdom, and 117 abroad, recognized by Lloyd's for the production of steel for use in the construction of vessels and machinery intended for classification in Lloyd's Register. Prior to any establishment receiving such recognition it is necessary that the works shall have been inspected and satisfactorily reported upon by the society's surveyors.

The total length of chain cable tested during the year at the Public Proving Houses in the United Kingdom, all of which are under the superintendence of the society, was 649,556 fathoms, in addition to a large quantity of miscellaneous chains and samples. The number of anchors tested was 12,686.

In addition to the above establishments, there are nine anchor and chain cable testing machines on the continent of Europe, twenty-three in the United States and two in Japan, recognized by the committee for the testing of anchors and chain cables. In these cases the necessary tests are required to be carried out in the presence of surveyors to the society.

Principal Surveyorship at Glasgow

Mr. James Montgomerie, B.Sc., who has been many years on the chief ship surveyor's staff, and has acted as principal ship surveyor for the United States, was elected for the important position of principal surveyor at Glasgow, in succession to Mr. French.

World Wide Demand for American Ships*

President of Naval Architects Society Summarizes Conditions Affecting American Shipbuilding—At Least Five Years of Prosperity Ahead

BY STEVENSON TAYLOR

THROUGH periods of alternate exaltation and depression, members of this society have retained their faith that some day there would arise such a demand for an American merchant marine that there would be no faltering in the future. It was not foreseen, however, that Europe would be almost entirely engaged in the fiercest war of history, bringing about unbelievable conditions, conditions with which our Government or citizens had nothing to do, for they are innocent of causing or participating in the frightful destruction of life and property that at present appalls the world. These conditions have brought to us the long-looked-for opportunity to build up our own marine commerce (as well as that of other neutral countries), and there is no reason for not availing ourselves to the utmost of this opportunity.

Statistics

This address promises to be mainly one of statistics. Many sources have been examined to determine the probable facts. It has been extremely difficult to obtain exact results, but a careful consideration of all of the sources warrants the figures given here in round numbers, and these figures, though perhaps not exact in themselves, do present existing conditions with sufficient accuracy to justify placing them on the record of your transactions.

Average Production of Shipyards

The year 1909, with a production of 1,602,057 tons, represents low tide, and the year 1913, with 3,332,882 tons, the high tide; therefore, the five-year period, 1910-1914, inclusive, fairly represents the average annual production of the shipyards of the world. This average was 2,740,000 tons gross.

	Tons
Of this amount the United Kingdom launched about 60 percent, or	1,650,000
Germany launched about 12 percent, or	330,000
United States coasts and Great Lakes (rivers not included) launched 9¼ percent, or	253,000
France launched 4½ percent, or	121,000
All other countries, including Great Britain's colonies and Canada, launched about 14 percent, or	385,000
	2,740,000

World's Tonnage

In the year ending June 30, 1915, the entire tonnage of the merchant vessels of the world amounted to 49,262,000 tons.

	Tons
The United Kingdom owned 43.5 percent, or	21,300,000
United States (excluding rivers and small lakes) owned about 12 percent, or	5,900,000
Germany owned 10 percent, or	5,000,000
France owned less than 5 percent, or	2,300,000

Taking the greatest tonnage of merchant vessels launched by any nation in any one year of all the years 1899 and including 1915, and combining same, we have a fair estimate of the capacity of the world's shipyards.

	Tons
These figures give a total capacity of	3,685,000
Of which the United Kingdom, colonies and Canadian lake ports launched 54 percent, or	1,984,000
United States Coasts and Great Lakes, 14.6 percent, or	540,000
Germany, 12.4 percent, or	465,000
All other countries, 19 percent, or	696,000

Conditions in 1914

In 1914 the building of merchant vessels was reduced by the European war to a minimum in all countries, the nations at war turning their attention almost entirely to the building of war vessels or munitions, while in the neutral nations it seemed as though marine, as well as all

* Annual address of President of Society of Naval Architects and Marine Engineers.

other merchant business, had come to an end; but in the last two years there has come a mighty change.

The destruction of some and the interning of the remaining merchant vessels of the Teutonic Allies; the commandeering of others by both sides, and the great destruction of merchant vessels of all nations, including neutrals, amounting now to 5,000,000 tons, has so reduced the number of available ocean ships that in order to transport the immense purchases of Europe and to furnish other ocean transportation there has arisen a demand never before seen for old, as well as new, ships, for anything indeed that could be used for oceanic service.

Present Conditions

The result has been that in the United States especially every vessel afloat, some extremely old, but every one available for the service, has greatly increased in value; every shipyard has been filled with orders for approximately two years, and many new yards have been established for the building of steel vessels; many old yards that built wood ships have been resuscitated, and many new yards also started for the building of wood vessels.

We are to-day, in our own country, in the midst of a shipbuilding boom unequaled in its history. It is to be remembered that command or freedom of the seas, depending on the point of view, is one of the very important causes of the war abroad, and that whatever may happen on land, at least Great Britain, Germany, France and Japan have the intention of being prepared, the first to hold and better if possible, its present superior position, and the others to increase the value of theirs, while the United States must now, if ever, regain its once formidable place on the seas of the world. There must naturally from these conditions come a great competition which will enlist all of the skill and efficiency of every nation having a merchant marine.

What is the condition to-day of the merchant fleets and what will be the tonnage requirements and the capacity of the world's shipyards in 1918? We have seen that the greatest production (the measure of capacity) of the world's yards up to 1915 was 3,687,000 tons. We estimate that in the year 1918 the capacity of the world's shipyards will be about as follows:

	Tons	Increase, Percent
United Kingdom, colonies and Canada	2,260,000	14
United States Coasts and Great Lakes	826,000	53
Germany	605,000	30
All other countries	809,000	16
Total	4,500,000	23½

The normal tonnage of the world this year amounts to about 50,000,000.

Of this there has been a tonnage:

Destroyed	5,000,000
Commandeered	12,000,000
Interned	4,400,000
Total withdrawn	21,400,000

Leaving available at present for regular service not more than 28,600,000 or 57.2 percent of the normal tonnage, which readily accounts for the present high freights and high values placed on old vessels.

	Tons
Presuming that peace will be restored by the end of 1917, we have present available tonnage as above	28,600,000
Commandeered and interned ships released	16,400,000
Probable production in year 1917	3,000,000
	48,000,000
Less future destruction, scrapping and depreciation	4,000,000
Leaving an available tonnage of	44,000,000
At the end of 1918, should peace be restored, there will certainly be required	55,000,000
Available at end of 1917, as above	44,000,000
Estimated construction, 1918	4,500,000
	48,000,000
Still leaving a tonnage deficit at end of 1918 of	6,500,000

From this it will be seen that high freights and high prices will continue and shipyards will be busy for some years to come, and it behooves all concerned, the Government, owners, builders and shippers to see that we obtain our share.

As to the increase in an American merchant marine flying the "Star Spangled Banner" the situation may be quite different, though we still hope not. At present the shipyards of the United States are building nearly 1,500,000 tons of steel and over 50,000 tons of wood vessels to be finished during the next two years.

Of these, at least 500,000 tons are for foreign account, and from reports recently received, this tonnage will be increased, so that about one-third of the vessels now contracted for in this country will fly foreign flags, mostly the flag of Norway.

At the present high freights, notwithstanding the high cost of building, owners can well afford to pay the difference between operating under the American flag and that of a foreign country, but possibly future conditions may change the special advantage we now possess.

Foreign Vessels Under American Registry

The European war has aided the merchant marine in the number of vessels registered as well as in the number contracted for in American yards. To September 26 last there were in all 196 foreign-built vessels of 642,802 tons admitted to American registry, but there were 261 American-built vessels of 151,676 tons sold to foreigners, leaving a balance of 491,126 tons, almost 10 percent increase in tonnage of American registry.

When the war ceases and the competition before referred to commences, it will be the privilege of the United States Government to aid ship owners to obtain their share of the freights then paid, be the same high or low.

The Shipping Board

What sort of protection, if any be necessary, shall be provided, and what changes in existing laws containing burdensome clauses shall be made, remain to be seen, and upon the lately authorized Shipping Board, with its extensive power, depends such recommendations to Congress as shall best be enacted.

Announcement has not yet been made of the personnel of this board, but we have no doubt that it will be of high character and that it will possess a general knowledge of the whole subject. Certainly, the Shipping Board will have an opportunity to afford great assistance and encouragement to those who desire to own and man ships to carry our flag over the seas and to do our share of the world's commerce without expending an undue amount of the $50,000,000 (£10,250,000) appropriated for its use.

A Government Shipping Company

In this connection it is interesting to note the establishment of the Belgian Shipping Company under the auspices of the Belgian Government, with a capital of 50,000,000 francs ($9,650,000), and of which all officers must be Belgian, born in Belgium; all stockholders must be Belgian, and no stockholder can be a partner or director of other companies of which the majority is not composed of Belgians, born in Belgium.

Marine Insurance

There has been recently one great change favorable to a firm establishment of an American merchant marine. For years the matter of marine insurance has been mostly left to foreign companies. As in other features of our business, we have been too busy with our inland matters to appreciate the worth of attention to marine insurance.

Only six months ago we were told that ship owners must go abroad for their insurance, and having had that habit for years it still was thought necessary. But we are

now in quite a different position, for insurance has been placed in this country for large amounts on single ships, and, wonder of wonders, insurance is being placed here for foreign owners.

United States Government Insurance

Here we should note the result of our own Government's operation of war risk insurance. From September 2, 1914, to July 31, 1916, the United States Government issued 1,539 policies, insuring $138,392,389 (£28,400,000) on American non-contraband cargoes, for which it received $2,904,886 (£600,000), with net losses amounting to $712,578 (£146,000), making a gross profit of $2,192,384 (£450,000). Deducting salaries and operating expenses, $32,982 (£6,750), leaves on policies issued during twenty-two months a net profit of $2,159,416 (£442,500).

Perhaps the Government cost did not cover all of the charges to which private insurance companies would be subject, nevertheless the experience warrants the careful attention of insurers as well as insured.

Nativity of Crews

One of the grave questions that arises in consideration of the American merchant marine is the one concerning crews. We do not suppose that at any time in the past crews of American ships were all native born, but it is quite certain that for a good many years the number of native born Americans serving on ships has gradually been decreasing. In 1909 about half of the crews on American ships were natives of the United States, while last year the proportion was reduced to 43 percent. We believe that there still remains something of the romance of the sea and its sailing ships, and given a world-wide trade our ships with power or without will attract more and more of our natives to service on board. We also have the alternative, the employment of those of foreign birth who will become our citizens. Here, as in other industries, the kind of immigration matters greatly. Our laws covering the question of physical and mental fitness must be strictly enforced. It would then seem that our American ships would be attractive to the best of sailors of whatever birth.

Committees on Fire Resistance and Bulkheads and Load Lines

As to your own direct interest as naval architects, two recent movements deserve especial mention. It is to the credit of Hon. William C. Redfield, Secretary of the Department of Commerce, that he called into service naval architects, shipbuilders, owners and operators to aid by conferences in the solving of two very important questions relating to vessels.

The first conference, held last May, on the subject of reducing the fire risk resulted in the testing by the United States Board of Standards of all sorts of materials that may render construction of vessels fireproof or nearly so. When these tests shall have been completed the competent committee appointed will report its recommendations.

The second conference, held last September, discussed the subject of subdivision of ships by bulkheads, and the equally important subject of assignment of load lines above which ships must not be loaded.

These subjects were referred to a committee of nine, seven of whom happen to be members of this society. It is needless to say that this committee, composed of naval architects, builders, owners and the president of the classification society, American Bureau of Shipping, will give the subject the most careful attention that it may be able when the time comes to give such information and advice to Government officials as they may require.

Subjects like the subdivision of ships by bulkheads, and assignment of load lines should be, as far as possible, treated as international.

For transoceanic service we should adopt the rules suggested by the Conference on Safety at Sea, held in London in 1913-1914. There still remains what appears more difficult of solution, our own Atlantic Coastwise, Pacific Coastwise and Great Lakes services, each of which brings problems of its own requiring the utmost careful consideration.

The Future

So far as shipbuilding is concerned, the figures already given for merchant vessels now being constructed and to be hereafter built prove that we are on the eve of great prosperity.

Make from the statistics herein given your own analysis. Mine is to the effect that there is before us a prosperous period of at least five years in which we can improve our facilities and methods so much that there will be no question of our shipyard efficiency and ability to meet competition, provided that our Government and Shipping Board really reason together face to face with our shipowners, shipbuilders and shippers, and determine to adopt the best policy to advance that most necessary and beneficial feature of our industries, an American merchant marine. Let there be no more periods when our grain and produce cannot be delivered for want of American ships, or times when any foreign government shall say what non-contraband goods can or cannot be shipped from our own ports.

Only the merchant marine service has thus far been considered, but the navy must not be forgotten. Add to the merchant ships which must be built in our yards the proposed increase in the navy, for which sixty-six ships of various classes are soon to be contracted for, at an estimated expenditure of $185,560,000 (£38,000,000), with armor, armament or navy ammunition, for which $66,595,000 (£13,650,000) more is required. Consider that included in this appropriation are the new battle cruisers designed by members of this society. The design of these battle cruisers is the most wonderful of all steps in the progress of designing skill, for in these ships are massed unprecedented power and unequaled speed and means of offense.

These facts are enough to fire your enthusiasm, but if you have listened with fair attention you have noted that there has been no indulgence in heroics. I trust, however, that you will have observed an underlying note of absolute faith in the future position and prosperity of our country, which must also carry with it the prosperity of those who build, own, operate and use our ships.

I see no chance of failure in the future. We need men, but they will come from the warring nations, tired of their systems of government and rejoicing to become American citizens. Men, too, will be raised to find their opportunity in the steadily alive shipyards of the future.

Our nation will again be a great maritime nation, holding its own among the other great nations of the earth. To feel otherwise would be a confession that our great Republic—now 141 years old—is a failure in self-government, enterprise, industry, efficiency and foresight, an appalling failure in those qualities that make men and great nations. This surely cannot be—it must not be.

Institution of Naval Architects.—The next annual meetings of the Institution of Naval Architects will be held in London on March 28, 1917.

Motor Boat Show.—The thirteenth annual Motor Boat Show will be held in Grand Central Palace, New York city, January 27 to February 3, 1917.

MOTOR YACHT GEORGIANA III PROPELLED BY SOUTHWARK-HARRIS DIESEL TYPE ENGINE

Built by Harlan & Hollingsworth Corporation, Wilmington, Del.

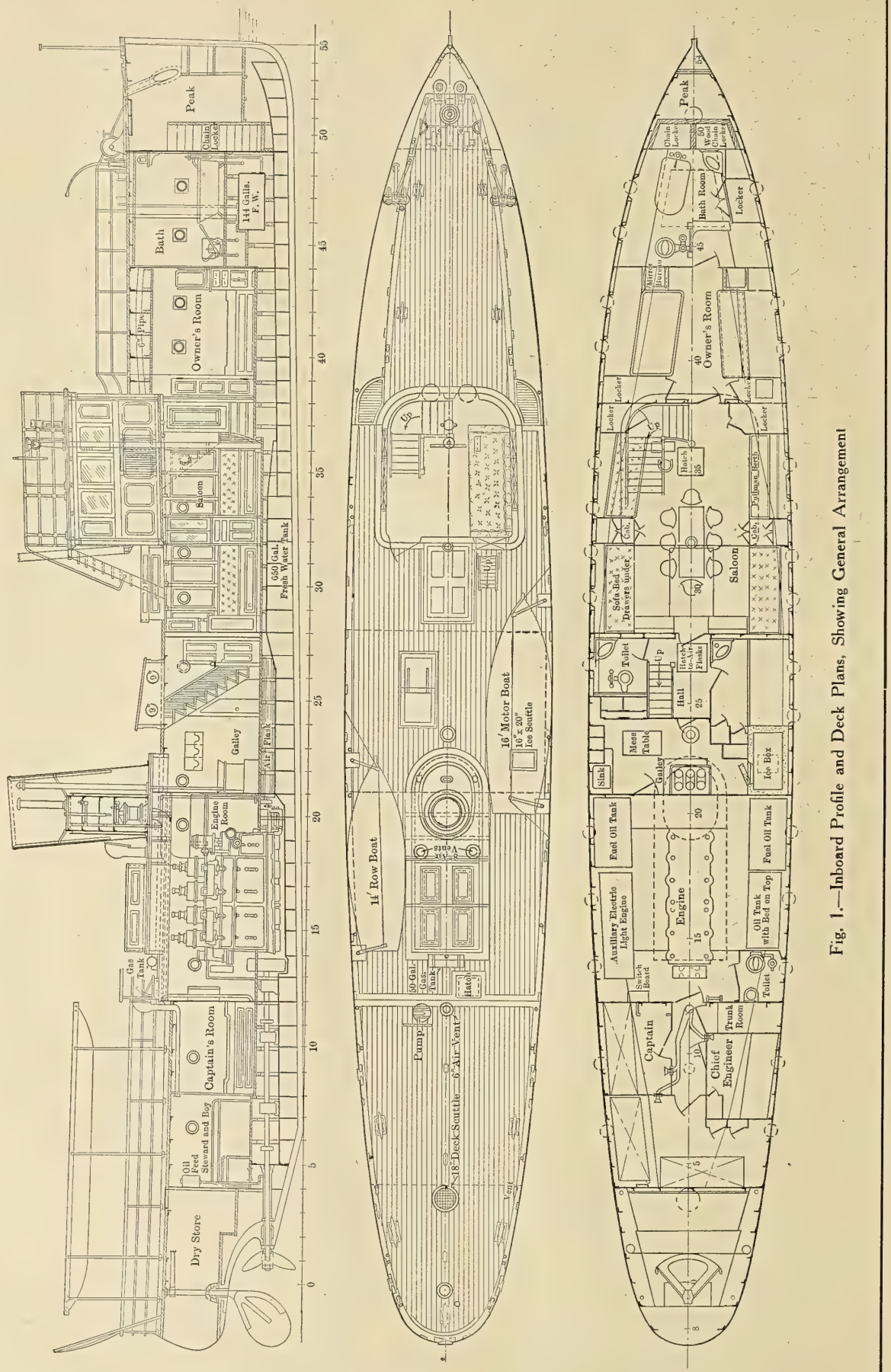


Fig. 1.—Inboard Profile and Deck Plans, Showing General Arrangement

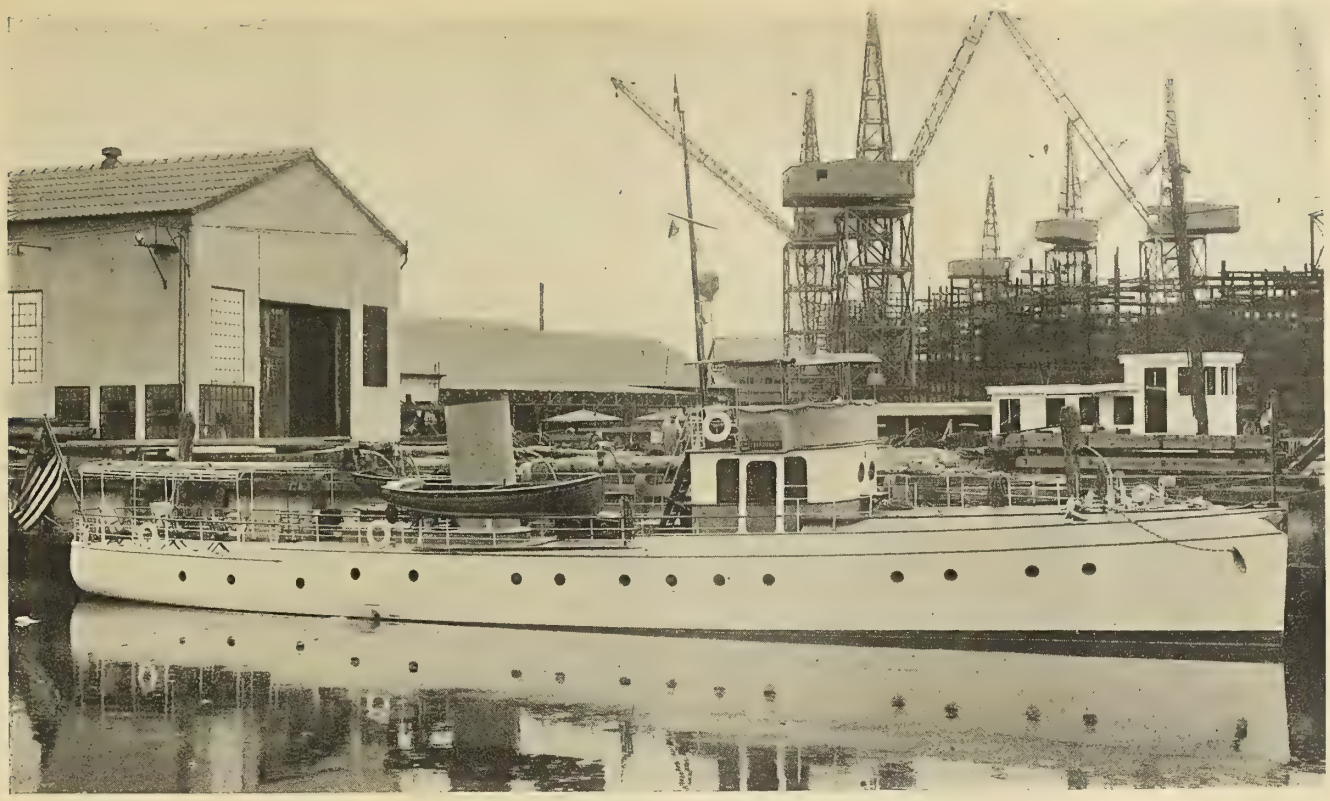


Fig. 2.—Motor Yacht Georgiana III at Builders' Fitting Out Dock

Diesel Engined Yacht Georgiana III

THE motor yacht *Georgiana III*, recently built by the Harlan & Hollingsworth Corporation, Wilmington, Del., for Mr. William Griscom Coxe, president of the company, is unique in many respects, embodying the owner's ideas of maximum strength and safety with minimum of ballast to obtain all necessary desiratum as to speed, stability, comfort, etc. The yacht was designed by her owner and Mr. A. M. Main, naval architect for the builders, and is propelled by a Southwark-Harris, Diesel type oil engine of 240 indicated horsepower. Her principal dimensions are as follows:

Length over all	95 feet 2½ inches
Length between perpendiculars	90 feet 0 inches
Beam, molded	15 feet 0 inches
Beam, extreme	15 feet 2 inches
Depth, molded above top keel	9 feet 4 inches
Draft	5 feet 6 inches
Gross custom house tonnage	82 tons
Net custom house tonnage	44 tons

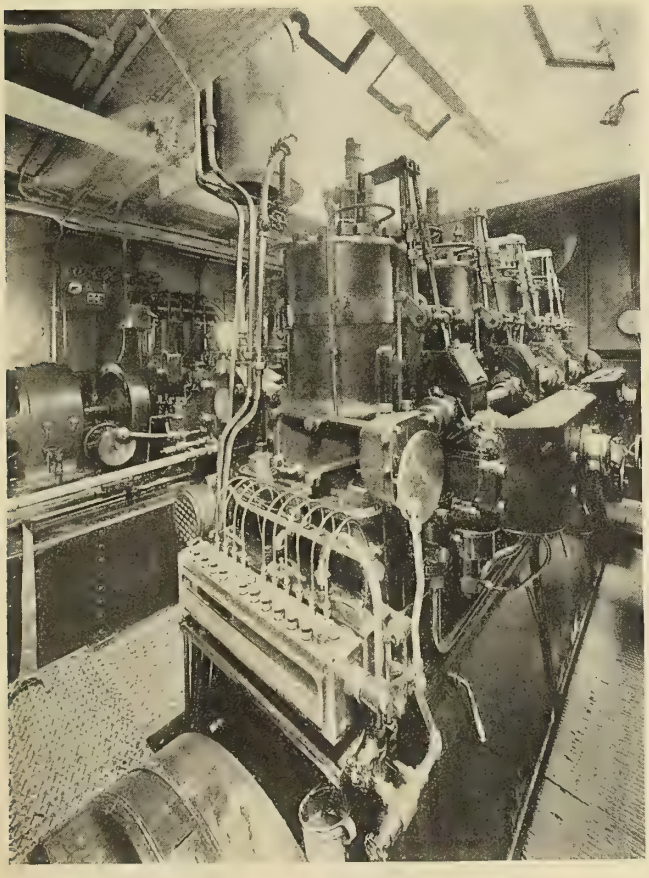


Fig. 3.—Engine Room

The vessel has a center vertical through plate keel, ½ inch thick under the machinery, with side bars. At the ends this keel becomes merged into a bar type keel, 5 inches by ⅞ inch, and steel bar stem rabbeted and sharpened on fore edge, the stern post being a steel casting taking the boss of the single shaft and rudder post.

For a portion of her length a double bottom is constructed on the cellular principle to carry fresh water. The frames are of bulb angle, 3 inches by 2 inches by 3.6 pounds, spaced 20 inches centers. The hull is divided into seven watertight compartments by six steel bulkheads. Four of the bulkheads are fitted with watertight doors of similar type to those on torpedo boats. The peak bulkheads are not pierced by doors. The two side keelsons are composed of double bulb angles fitted back to back. Beams are of bulb angles, 3 inches by 1¾ inches by 3.25 pounds, fitted to every frame. On the forecastle the deck beams are of angle section. The floor plates, garboard strakes of the shell and sheer strakes are of 10-pound plate, the thinnest shell plating being about 7 pounds. The upper shell is built flush and smooth, having straps fitted at the edges and butts; below the water the edges are overlapped.

The upper deck, quarter deck and forecastle deck are

plated with steel stringers and tie plates lightened by holes. The skylight over the engine room and the deck house are of steel. Steel bulkheads and steel decks enclose the galley and obviate the spread of fire originating there.

The forecastle, bridge, upper and quarter decks have mahogany margin planks and narrow white pine planking fastened from below with brass screws and all payed with marine glue.

The general arrangement of the vessel, which embodies the owner's ideas is almost identical to that of the *Georgiana II.* The old yacht was 70 feet over all length, and in the new yacht the owner's quarters are more spacious, while an additional room and improved galley and storeroom arrangement was obtained. The crew's quarters are also very much better.

Fig. 1 shows the layout and arrangement of the various decks.

Beginning forward, the fore peak, in which water ballast can be carried if desired, is piped to the bilge pumps, a locker being built in the peak for stowage of chain cable. In the owner's bath room the walls and ceiling are covered with sanitary "Like-tile" and the floor with inlaid linoleum. The room is lighted and ventilated by four side lights or ports, and has a small sirocco suction fan for discharging vitiated air.

The owner's bedroom has neatly paneled walls and ceiling finished in white enamel. The floor is carpeted, the color of the carpet and draperies being cobalt blue. This room has four side lights, or air ports, and a safe is fitted into one of the four lockers.

The main saloon is paneled in quartered oak, all furniture and beams overhead being in oak. The ceiling panels are of ply board, painted cream white. The upholstery and wall panels are of English tapestry, which, with the carpet, is of design and color harmonizing with the brown oak. Light and ventilation are provided for by eight 9-inch side lights, or air ports, and a large overhead skylight. The stairway at the forward end lands in the deck cabin, which forms the main entrance to the owner's quarters. This main saloon has a steel watertight bulkhead at either end.

Abaft the saloon is a hallway with stairway to a companion on the upper deck. Opening off the hallway is a guests' toilet finished in "Like-tile," the floor being covered with interlocking tile, as in the hall. On the starboard side of the hall is a children's room finished in enamel white and with carpet and draperies like those in the owner's room.

The galley is separated from living quarters by a metal bulkhead. The floor of the galley is covered with asbestolith, while all dish racks and lockers are of metal. The sink is provided with a pump, which can draw from the sea or fresh water from main tank. The range is a Shipmate, with hot water back and hot water tank and sits on a metal coal box. The ice box is built into the vessel, efficiently insulated, the ice being put into the box through a watertight scuttle on upper deck. The galley is ventilated by portion of main stack, which extends over the range, and is lighted by two sidelights, or air ports, and a deck light.

The deck cabin is paneled full height in white mahogany and has seven large plate glass drop windows with two 15-inch diameter sidelights in front. A large built-in davenport, with seat, back and arms, upholstered in Spanish leather, a card table and movable chairs, complete the furniture of this room. Pullman shades, mosquito screens and storm shutters are provided for the windows. The white mahogany is finished natural color, the carpets, upholstery and window shades being green.

The deck house is of steel, but the upper part above the window rail outside is paneled in mahogany. The saloon skylight and companionway are of mahogany. The top of deck house is utilized for a navigating bridge and is extended at the forward end to the sides of the vessel, giving the navigator a view along the full length of the yacht.

The engine room, located abaft the galley, is bounded by steel watertight bulkheads. Fuel oil tanks independent of the yacht's structure are fitted on each side of the engine room. A toilet for the crew's use is enclosed in metal bulkheads at the aft end of the engine room. The main engine foundations consist of fore and aft girders, which take the holding down bolts. These girders are connected to the shell of the yacht and to deep floor plates, making a rigid foundation. The engine driving the air compressor and electric generator are on one foundation and sit on one of the oil tanks, which is strengthened to suit.

The engine room is lighted and ventilated by the stack, six 9-inch sidelights, or air ports, and by a steel skylight having four rectangular sections, which are raised by rods, each section having rectangular wired glass for light. Two 8-inch copper cowl ventilators and a booby hatch are also provided.

The crew's quarters extend from the after bulkhead of the engine room to the after-peak bulkhead. In the after castle two metal beds are provided for the deck hands, also two lockers. A trunk room is also provided for in the after quarters.

The lazarette abaft the peak bulkhead is entered through a watertight brass deck scuttle. This space in the cruiser stern is commodious, and here are stowed the storage batteries, etc. The quarter blocks and quadrant, with tightening device for steering ropes, are located here, and are accessible.

The steering gear consists of a brass steering column with hardwood wheel operating the shaft, which, through gearing and pinion, drive a rack to which the steering wire ropes are attached. The ropes are carried under the deck to the quadrant in the lazarette.

Communication between the navigating bridge and engine room is by means of telegraph and speaking tube. The usual navigating instruments are installed. The compass is a 3-inch liquid in a brass-headed compensating binnacle on mahogany column of Hand's make. A Gray-Hawley whistle, operated by compressed air, and a Klaxon is also provided and located on the mast; also an 8-inch fog bell and searchlight are fitted on the mast and controlled from the bridge.

The mast carries a cross yard for flying signals. The windlass, made by the American Engineering Company, is a No. 3 Providence, and is equipped with elastic chain stoppers.

The equipment of the yacht consists of 105 fathoms 10/16 chain cable, two 240-yound anchors and kedge anchor, with all necessary ropes, running lights, signals, life preservers, fire hose, fire extinguishers, etc., required by law. She has a 14-foot tender or dingy and a 16-foot motor launch made by Luders Marine Construction Company, Stamford, Conn.

The pumping of bilge and peak tanks is performed by a bilge pump on an auxiliary engine and by a rotary hand pump attached to a manifold, from which pipes are led to the various bilges and tanks. A bilge pump is also attached to main engine. The rotary pump has a connection to the sea, also is used for fire or wash deck purposes.

The yacht is propelled by a Southwark-Harris valveless engine—Diesel principle—designed to indicate 240 horse-per minute. The engine has four cylinders, 9-inch diam-

eter, 13-inch stroke. The fuel used is crude or fuel oil. The engine is started from rest by compressed air, and when stone cold can be brought to full power in 10 seconds. This engine is directly reversible and can be put from "full ahead" to "full astern" in 5 seconds. It has been fully described in previous issues of this journal.

The engine on the *Georgiana III,* after the usual preliminary trials and adjustment, has given entire satisfaction and has run for a day at a stretch in rough weather without any more care than a steam engine would require. The oil tanks have a capacity of 1,070 gallons, and at a consumption of 8 gallons per hour when running at a speed of 15 miles per hour, give the yacht a cruising radius of almost 2,000 miles on one filling of tanks. The air bottle containers for compressed air, which is used for starting engine, forcing and vaporizing the fuel, blowing whistle, etc., have a capacity—without recharging—to enable the engine to be stopped and started fifty times.

The propeller is 4 feet diameter by 60 inches pitch.

The auxiliary machinery consists of a 12 to 16-horsepower Frisbie gasoline (petrol) motor, driving a direct-connected, 3-kilowatt electric generator, and also driving, from the same shaft extended forward, a 4½-inch by 5-inch air compressor and a bilge pump. The gasoline (petrol) for this motor is carried in a tank on deck, which also carries a supply for the motor launch. The lubricating tanks are carried high on the side of the yacht, and an oil fuel supply pressure tank is also carried high up on the side. The engine room is well arranged and practically no wood is visible except the seat and gage boards.

The telegraph receiver, speaking tubes and gages are on the forward bulkhead, near the starting wheel of the main engine. The yacht is lighted by electricity, the running lights being a combination of oil and electric. The searchlight fitted on the mast is a 9-inch General Electric. The switchboard is located at the aft end of the engine room, near the generator.

The *Georgiana III* has proved to be a very comfortable off-shore cruiser. She has roomy, clear decks, the quarter deck having ample space for chairs. The forecastle and bridge decks, due to the vessel's freeboard, are dry in any weather when the wind has a velocity less than a gale. When at rest her quarter deck is 4 feet 6 inches above the load waterline, the bridge deck 5 feet, the forecastle 8 feet 6 inches, and the navigating bridge 12 feet. She has been tested out in cruising between New York and Norfolk, Va., having encountered at times a gale of 40-mile velocity blowing against the tide and creating high seas. Her behavior in such conditions is reported as ideal, her motion being like that of a vessel under sail and her decks practically dry. Her owner and captain have the utmost confidence in her ability to go anywhere, as she is strongly built and can stand severe handling.

AWARD OF NAVAL CONTRACTS.—Contracts for the four battleships authorized by the last Congress will be evenly divided between the New York Shipbuilding Company and the Newport News Shipbuilding & Dry Dock Company. Contracts for the construction of 27 coast defense submarines and two 800-ton fleet submarines were awarded on November 29 to private shipbuilders. Eighteen of the coast defense and one fleet marine will be built by the Electric Boat Company; 6 coast defense and one fleet submarine by the Lake Torpedo Boat Company, and 3 coast defense submarines by the California Shipbuilding Company. A third fleet submarine will be built at the Portsmouth Navy Yard.

Rules for Ordering Rivets

BY WILLIAM M. KENNEDY

The following very simple rules—having been developed from practice—give excellent results in ordering rivets.

Order lengths for flush point rivets, countersinking done under Lloyd's rules.

To total thickness of plating add thickness of top plate plus ¼ inch for two-ply, for each additional ply add thickness plus additional ⅛ inch.

Example—Order rivets for driving flush points in a connection consisting of two 5/16 inch and one ⅜ inch plate, the latter being the top plate.

Thickness of three plates, 5/16 + 5/16 + ⅜	=	1 inch
Thickness of top plate	=	⅜ inch
Added length for two-ply	=	¼ inch
For one additional ply over two	=	⅛ inch
Length to order	=	1¾ inches

Ordered lengths for flush point rivets, countersinking done under United States Navy rules.

To total thickness of plating add thickness of top plate plus ⅛ inch for two-ply. For each additional ply add thickness of ply plus ⅛ inch. For excessive thickness ¼ inch should be added for each ply over two.

LLOYD'S COUNTERSINKING

"The countersink is to extend through the whole thickness of the plate when less than 14/20 inch thickness; when 14/20 inch or above the countersink is to extend through nine-tenths the thickness of the plate."

UNITED STATES NAVY COUNTERSINKING

"Holes for countersunk heads and points should extend through the plate or shape when the thickness of the metal is ¼ inch or less. Where the thickness is greater than ¼ inch the depth of the countersink will extend about 1/16 inch less than depth of standard rivet heads."

It will be seen from the countersinking rules that the thickness of the top plate determines the additional length of rivet required to fill countersink.

As all holes in ship work are not fair or accurately fitted, it becomes necessary to ream them; this increases the area to be filled by the rivet. The rule takes care of this condition. The rivet in a hole requiring no reaming or recountersinking will have a medium-sized chip to take off; the general run of the holes will require a very light chip be taken off rivets, while in the passable hole the rivet will just fill countersink. Holes that do not meet the last condition should be reamed to the next larger diameter.

When convex heads are required an additional ⅛ inch should be added for each ⅛ inch height of convex.

For snap or button head riveting a table will simplify the rule, which is as follows: For ⅜ inch diameter, two-ply of plating 1-inch stock in addition to thickness will be required to form head, for each and every increase of diameter or ply an addition of ⅛ inch in length plus thickness of plates will be required to form head.

Table for ordering snap or button head riveting, derived from the above rule, base being ⅜ inch diameter, two-ply of plating.

Diameter of Rivet. Inch	Two-Ply. Inches	Three-Ply. Inches	Four-Ply. Inches
⅜	1	1⅛	1¼
½	1⅛	1¼	1⅜
⅝	1¼	1⅜	1½
¾	1⅜	1½	1⅝
⅞	1½	1⅝	1¾
1	1⅝	1¾	1⅞

To thickness of plate add tabulated length which will fill hole and form head.

As in shipwork holes are punched or reamed ⅛ inch greater in diameter than the diameter of rivet, and as the

thickness of plating governs the diameter of rivets by all rules, it can be understood why the greater lengths are required to fill holes and form heads on rivets as they increase in diameter.

When the lengths of rivets work out as odd sixteenths, order to the next higher eighth.

For compression riveting add ⅛ inch to lengths given in the table.

When ordering countersunk head rivets add ⅛ inch to length, as countersunk head rivets are measured over all and it is impossible without counterboring—which is impracticable—to make heads finish flush. The aim is to have them slightly high, hence the additional ⅛ inch. Other types of head have no bearing on ordered length.

There should be no local conditions existing that would alter lengths required for standard riveting. The practice of using larger or ground down dies to utilize some size of rivets on hand cannot give best results. The rivets for countersunk work will work out as stated, if the countersinking is done according to rules and recountersunk when cut away in reaming.

With standard methods, standard machines and dies and standard method of work specified by registration societies and United States Government, there seems no logical reason why these rules will not work out satisfactorily for any yard.

Notes from the Model Basin*

Effect of Surface Condition on Efficiency of Propellers—Air Resistance of Ship's Model

BY NAVAL CONSTRUCTOR WILLIAM MC ENTEE, U. S. N.

DURING the last year at the United States Experimental Model Basin the press of routine work has been such as to prevent any original investigations which would require the use of the basin for any great time. There has been opportunity, however, to continue experiments relating to the part played by the frictional resistance of water in the resistance and propulsion of ships.

The results of the tests reported in my paper, "Variation in Frictional Resistance of Ships with Condition of Wetted Surface," read before the society last year, indicated the importance of the condition of wetted surface as affecting the resistance of a ship. As a natural extension of this investigation, an attempt has been made to ascertain the corresponding effect of surface condition on the efficiency of propellers.

The results as given in the present paper indicate that this is a matter of equal importance as affecting the economical operation of ships.

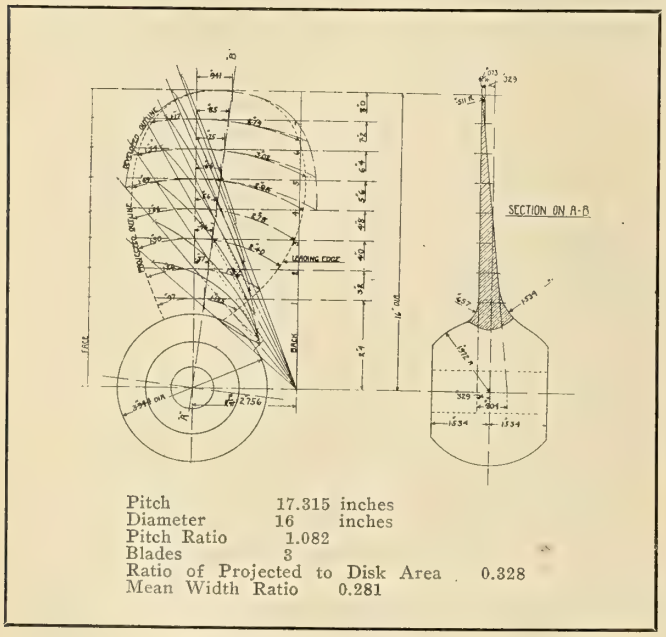


Fig. 1.—Model Propeller No. 285

Propellers used for naval work have customarily, especially on high-speed vessels, been carefully finished by machining the rear surface of the blades to a true helicoidal surface and finishing by hand the leading face so as to make the entire surface smooth and polished. In doing this, however, it seems that the object was as much to get blades which would have uniformity of pitch and balance as to get a smooth frictional surface. For merchant vessels propellers are commonly made with blades of cast iron or cast steel, and no finish is given except trimming off the rough places with a chisel or rough file.

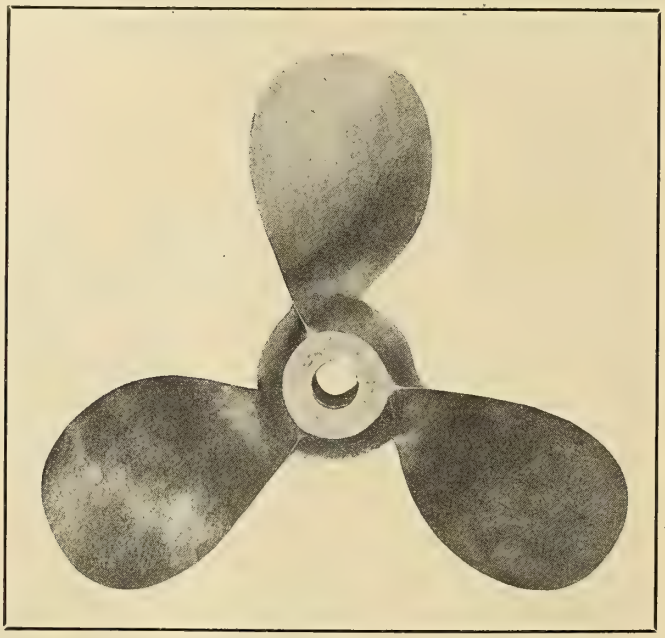


Fig. 2.—Model No. 285. Bronze—Smooth Finish

To ascertain what may be expected from the difference in naval and merchant practice, four 16-inch propellers, made as closely as possible to the dimensions shown in Fig. 1, were tested at a uniform speed of 5 knots. Two propellers were of bronze, one of cast iron and one of cast steel, and all were models of a propeller which has given excellent results in actual service on a battleship. The appearance of these models is shown in Figs. 2 to 5.

Propeller No. 285 was already on hand. It was ma-

* Paper presented before the Society of Naval Architects and Marine Engineers, New York, November 16.

PROPELLER MODELS USED FOR EXPERIMENTS

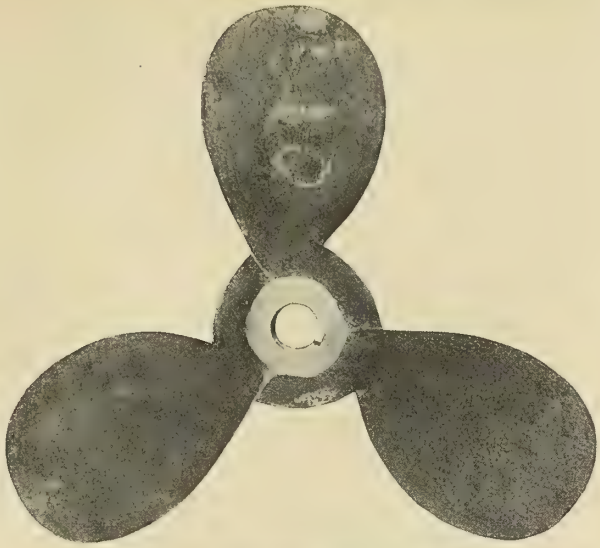


Fig. 3.—Model No. 310. Cast Bronze

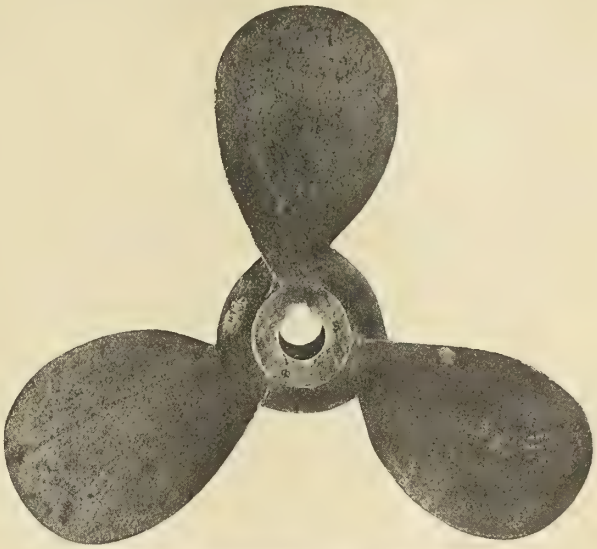


Fig. 4.—Model No. 309. Cast Steel

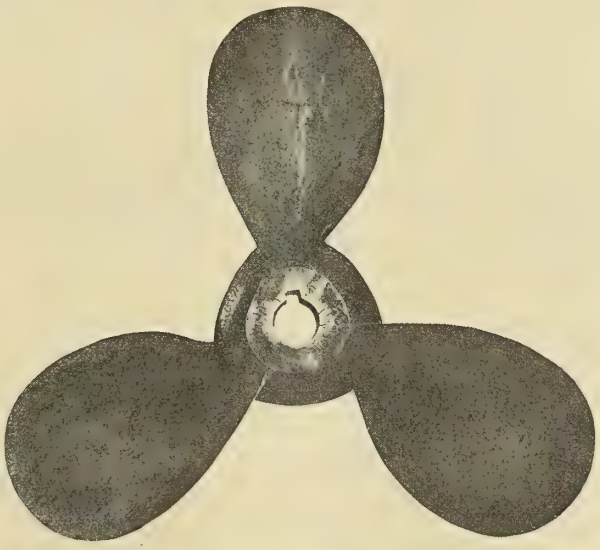


Fig 5.—Model No. 308. Cast Iron

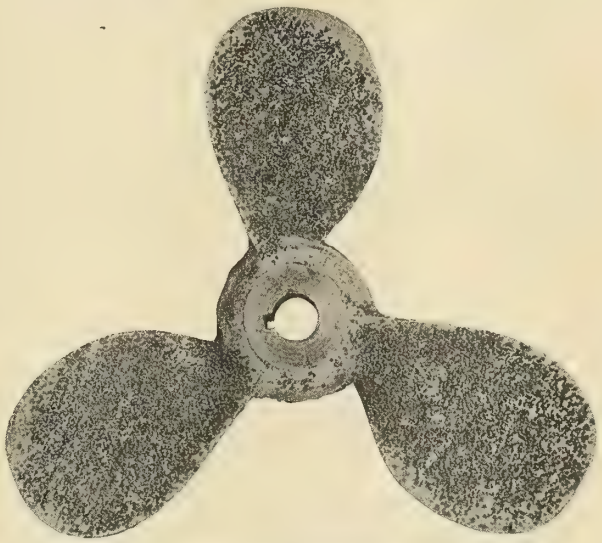


Fig. 6.—Model No. 285. Bronze—Smooth Finish and Cork Painted

chined to a true helicodal surface on the rear face of the blades, and finished by hand to a true surface of convex section on the leading face. The accuracy of finish was the same as that of the series of propeller models heretofore tested from time to time at the model basin. The three cast propellers were supplied through the courtesy of Mr. William Gatewood, naval architect of the Newport News Shipbuilding and Dry Dock Company. They were made from a separate pattern and were cast as nearly as possible to the finished dimensions of model No. 285.

The results of the tests are shown in Fig. 7, from which it will be seen that the effect of the rough surface of the models as cast is to reduce the maximum efficiency as compared with the smooth model from about 72 percent to about 63 percent.

When a vessel lies for even short periods in waters where fouling occurs rapidly there is frequently a considerable accumulation of barnacles and other sea growth on the propeller. In order to investigate the effect to be expected from the worst probable condition of propeller surface, propeller No. 285—that is, the bronze propeller with smooth finish—was varnished, and while the varnish was still soft there was applied a covering of granulated cork such as is ordinarily used in ship work for cork paint. The appearance of the smooth-finished model and of the same model covered with granulated cork is shown in Figs. 2 and 6. The results of the test are shown in Fig. 8.

From this it will be seen that the effect of the roughening of the surface is to reduce the maximum efficiency from about 72 percent to about 36 percent. If compared on the basis of the same thrust, the prejudicial effect of the rough surface will be even more pronounced.

Air Resistance of a Ship's Model

During the trials of the U. S. S. *Neptune* it was found that a considerable variation of power was required to maintain a given speed, depending on the direction and force of the wind. As the *Neptune* is a collier with a large number of coaling booms for rapid handling of coal, the top hamper presents a large area for the wind to act on, so an investigation of the air resistance seemed desirable.

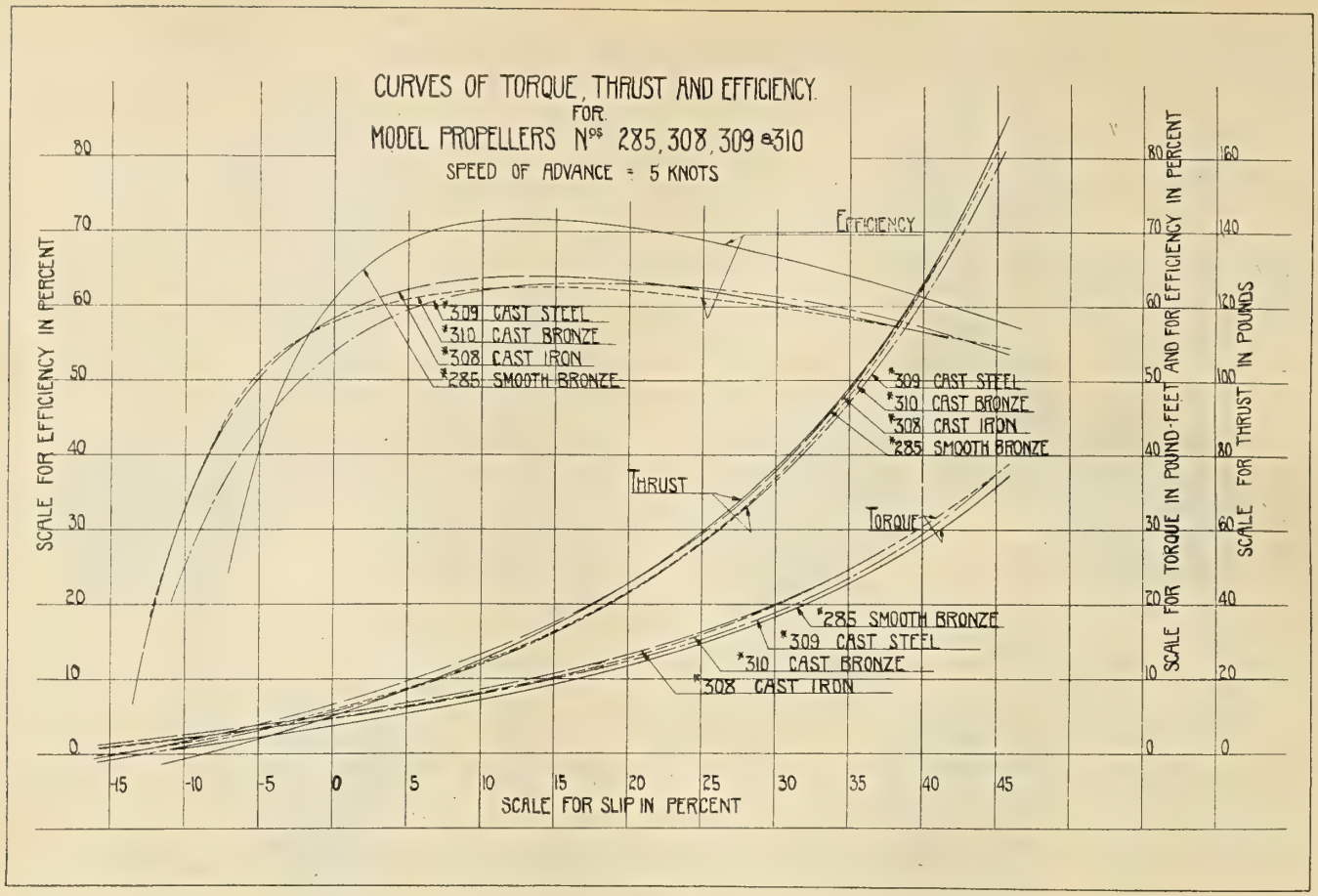

CURVES OF TORQUE, THRUST AND EFFICIENCY
FOR
MODEL PROPELLERS Nos 285, 308, 309 & 310
SPEED OF ADVANCE = 5 KNOTS
EFFICIENCY
*309 CAST STEEL
*310 CAST BRONZE
*308 CAST IRON
*285 SMOOTH BRONZE
THRUST
TORQUE
SCALE FOR EFFICIENCY IN PERCENT
SCALE FOR TORQUE IN POUND-FEET AND FOR EFFICIENCY IN PERCENT
SCALE FOR THRUST IN POUNDS
SCALE FOR SLIP IN PERCENT

Fig. 7

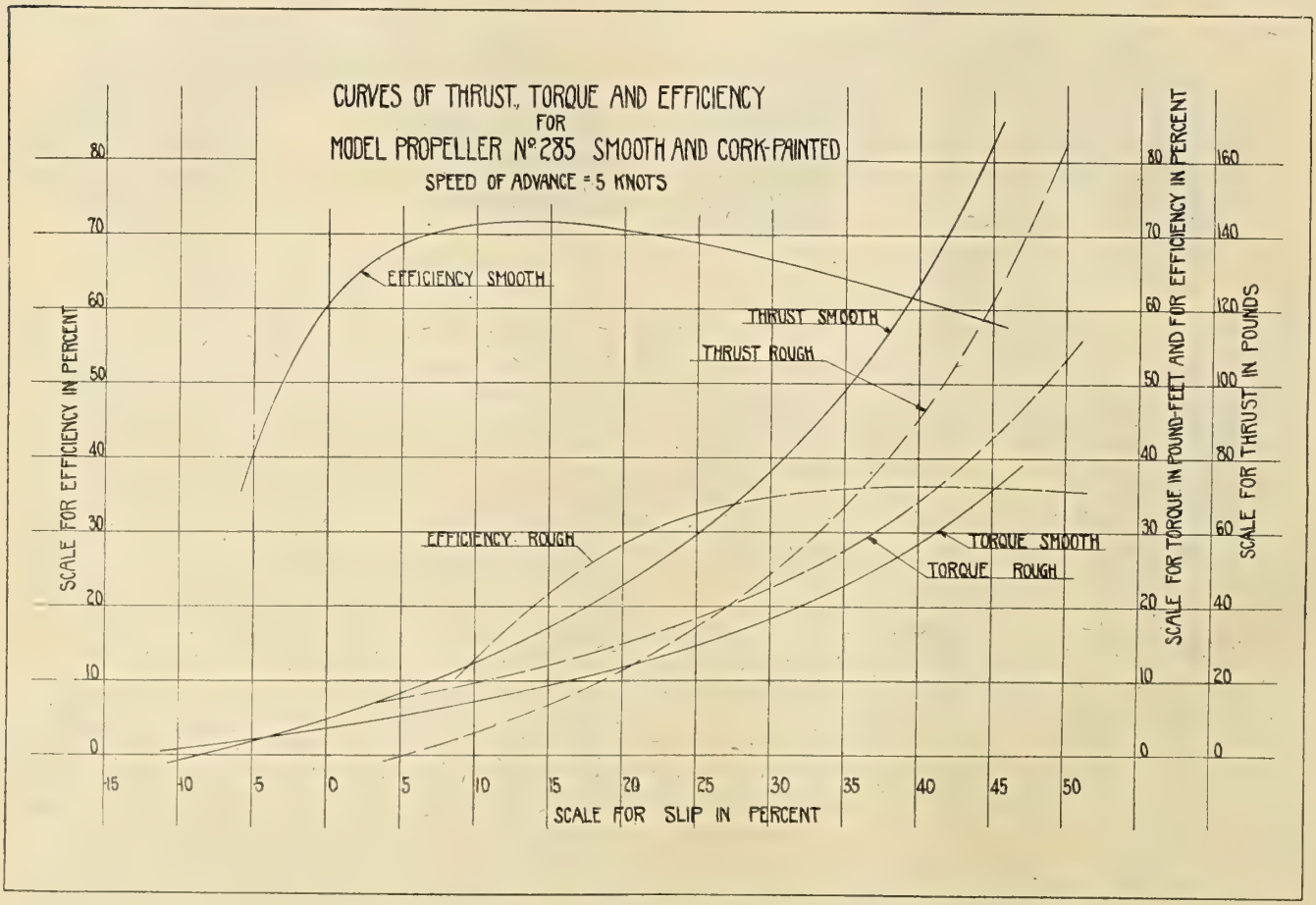

CURVES OF THRUST, TORQUE AND EFFICIENCY
FOR
MODEL PROPELLER N° 285 SMOOTH AND CORK-PAINTED
SPEED OF ADVANCE = 5 KNOTS
EFFICIENCY SMOOTH
THRUST SMOOTH
THRUST ROUGH
EFFICIENCY ROUGH
TORQUE SMOOTH
TORQUE ROUGH
SCALE FOR EFFICIENCY IN PERCENT
SCALE FOR TORQUE IN POUND-FEET AND FOR EFFICIENCY IN PERCENT
SCALE FOR THRUST IN POUNDS
SCALE FOR SLIP IN PERCENT

Fig. 8

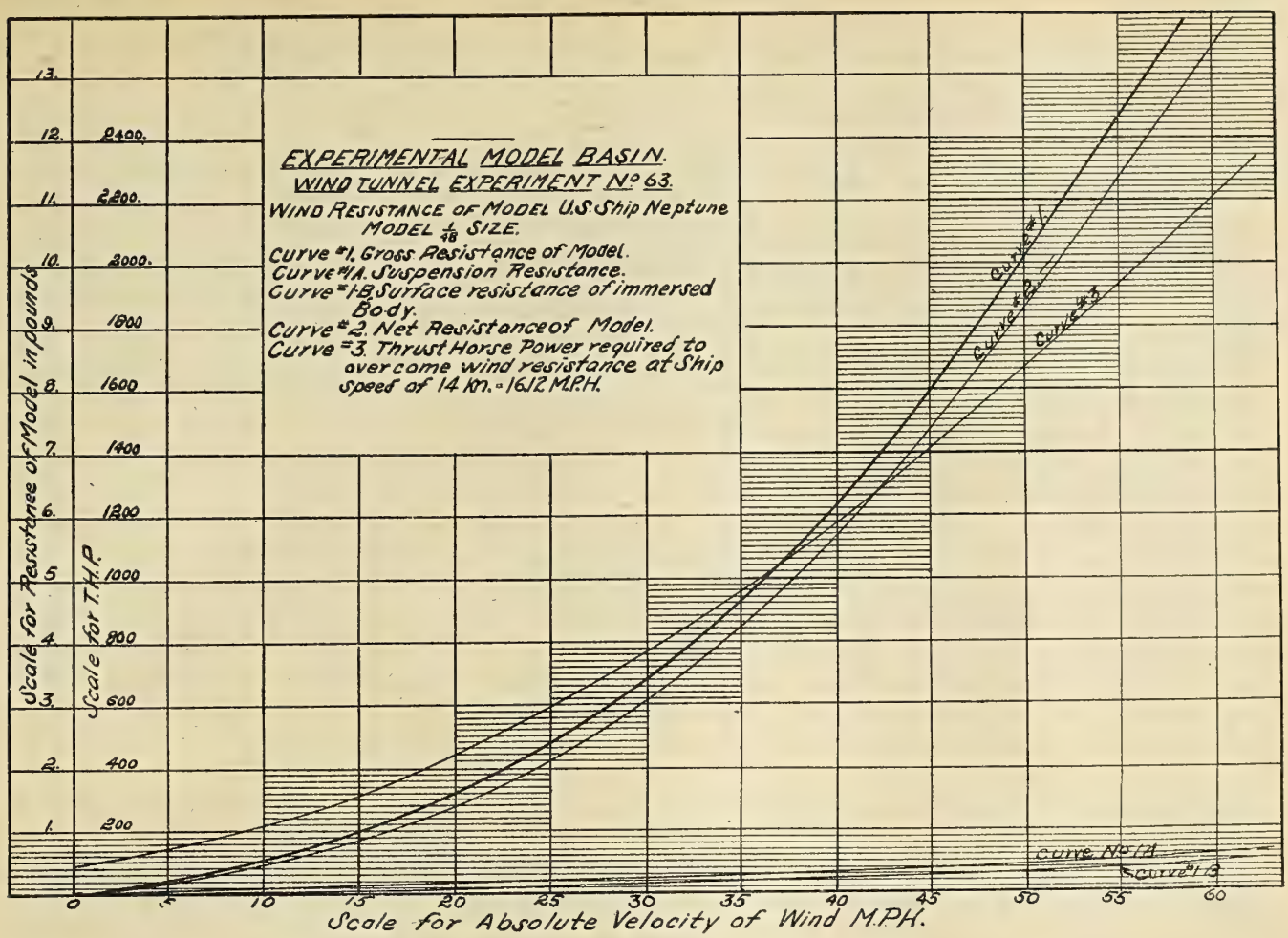

EXPERIMENTAL MODEL BASIN.
WIND TUNNEL EXPERIMENT No 63.
WIND RESISTANCE OF MODEL U.S. Ship Neptune
MODEL 1/48 SIZE.
Curve #1. Gross Resistance of Model.
Curve #1A. Suspension Resistance.
Curve #1B. Surface resistance of immersed Body.
Curve #2. Net Resistance of Model.
Curve #3. Thrust Horse Power required to overcome wind resistance at Ship Speed of 14 Kn. = 16.12 M.P.H.
Scale for Resistance of Model in pounds
Scale for T.H.P.
Scale for Absolute Velocity of Wind M.P.H.
Curve #1
Curve #2
Curve #3
Curve No 1A
Curve #1B

Fig. 9

As there was available an "Exhibition Model" of the ship to a scale of ¼ inch to the foot, on which all top hamper, including rigging and deck obstructions, were carefully fitted to scale, the resistance of the model was measured in the wind tunnel at the model basin.

On Fig. 10 is shown the appearance of the model as suspended in the tunnel, and on Fig. 9 the results of the test.

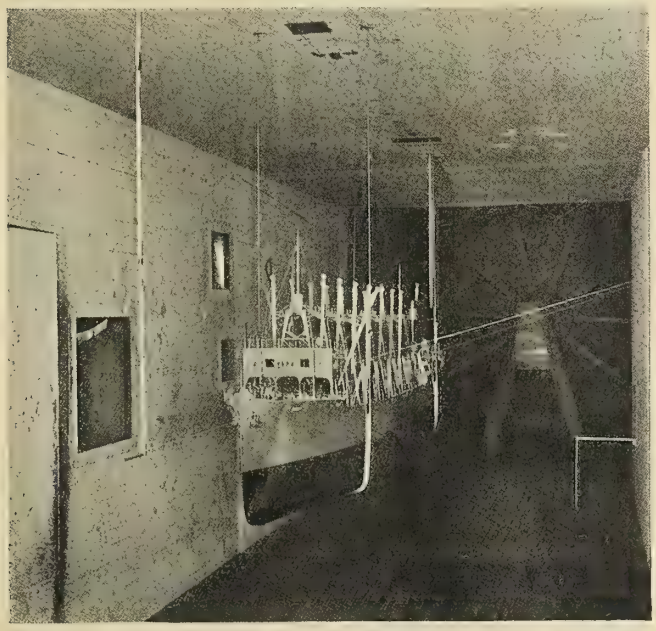


Fig. 10.—Model of Collier Suspended in Wind Tunnel

From model experiments in water it is estimated that the vessel, which is 542 feet in length over all by 65 feet beam, with a displacement of 19,340 tons at a draft of 27.5 feet, would require about 3,850 effective horsepower to attain a speed of 14 knots.

From the curves on Fig. 9 it will be seen that with a wind directly ahead with an absolute velocity of 30 miles per hour and velocity relative to the ship of about 46 miles, the additional effective horsepower to overcome wind resistance would be about 770, or 20 percent of the power to overcome the water resistance alone. This comparison leaves out of consideration any increase in water resistance due to waves. If the power developed by the engines were not increased, this additional resistance of the wind would cause a reduction in speed of about 1.9 knots.

In a general way the results of the test in the wind tunnel confirm the results obtained on trials of the vessel. No exact comparison, however, is possible, because of lack of accurate observation of the velocity of the wind at the time of the trials.

Moore & Scott Shipyard

On January 1, 1916, Mayor Rolf, of San Francisco, placed a contract with the Moore & Scott Iron Works, San Francisco, for the construction of a steel steamship, 376 feet long between perpendiculars, 52 feet 3 inches beam, molded, and 28 feet depth, molded, with a deadweight carrying capacity of 7,100 tons on a 23-foot draft. This is the first large steamship to be built at the Oakland shipyard of the Moore & Scott Iron Works, and to meet the requirements for this work and to fulfill other orders subsequently taken, the company has completely renovated

Fig. 1.—Moore & Scott Shipyard, Oakland, Cal., Showing Cantilever Yard Crane and Punch Shed and Furnace Building in Background

its shipyard, erecting new buildings and installing a complete equipment of new tools.

Three new shipways were installed and nine stationary tower cranes erected. These cranes consist of a framework with booms on each corner, as shown in the photographs. With the view of decreasing the cost of handling material, in addition to the new cranes, a complete system of broad-gage railroad track, as well as an industrial track system was installed. The material is unloaded from cars and taken direct to the punch shed by a traveling gantry crane which serves the entire plate yard. After leaving the punch shed the material is handled in the fabricating space by a 70-foot revolving crane.

New mill, joiner and pattern shops have been built and equipped with up-to-date tools. All of the punches are new and some large bending rolls have been installed, one set having rolls 25 feet in length inside the bearings and 28 inches diameter.

The Moore & Scott shipyard is equipped with an electrically operated 3,000-ton capacity marine ways and space is reserved for a large graving dock. The power house is equipped with large Ingersoll-Rand air compressors. In addition to the shipyard at Oakland, a large modern fully-equipped machine shop is operated in San Francisco.

Fig. 2.—Pattern and Joiner Shop

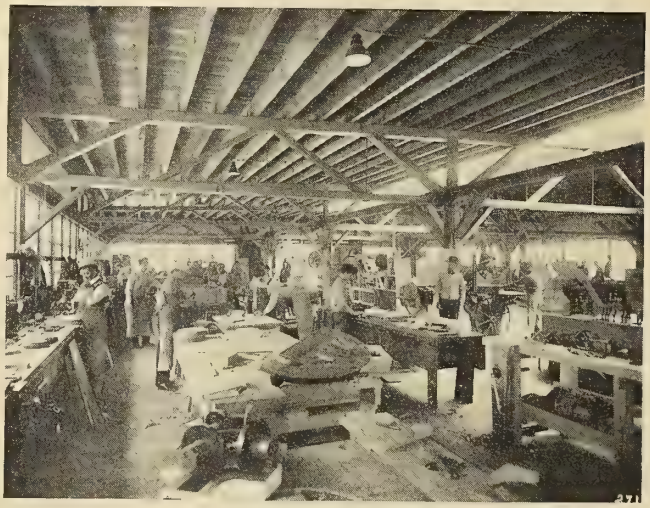


Fig. 3.—Interior of Pattern Shop

Fig. 4.—Drafting Room

Fig. 5.—Mold Loft

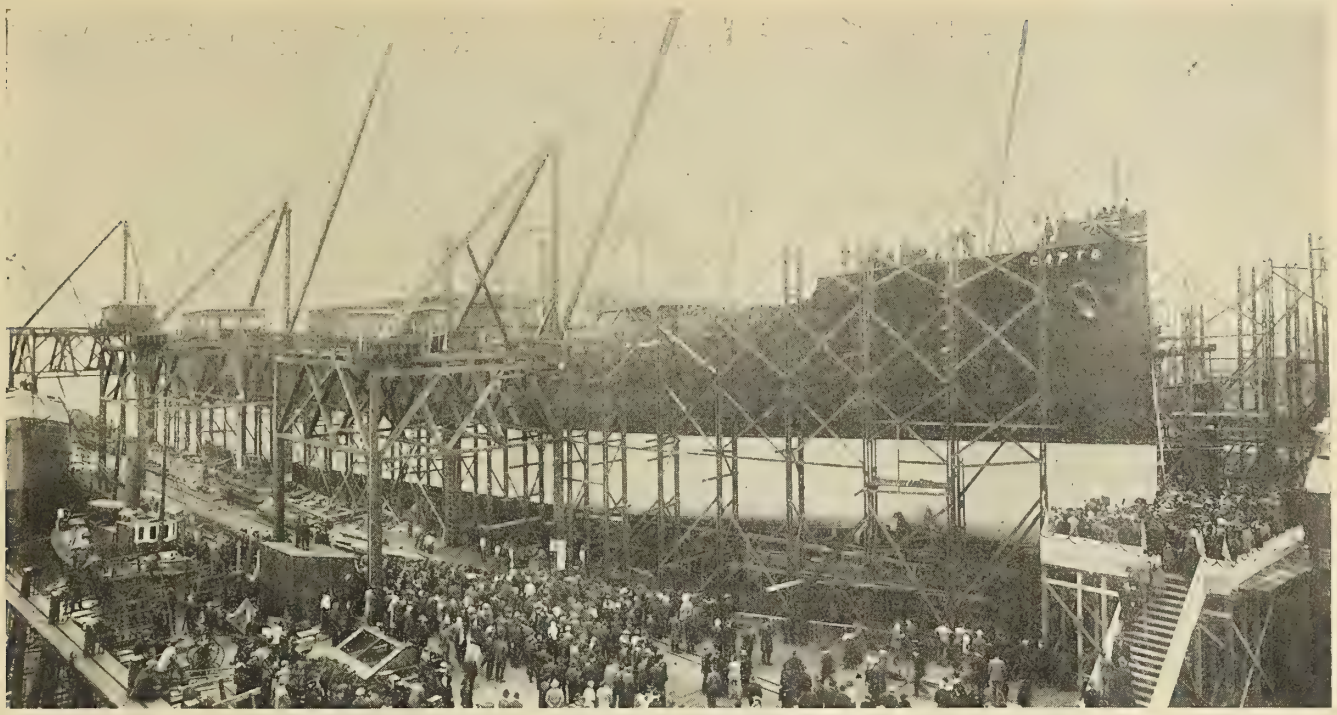
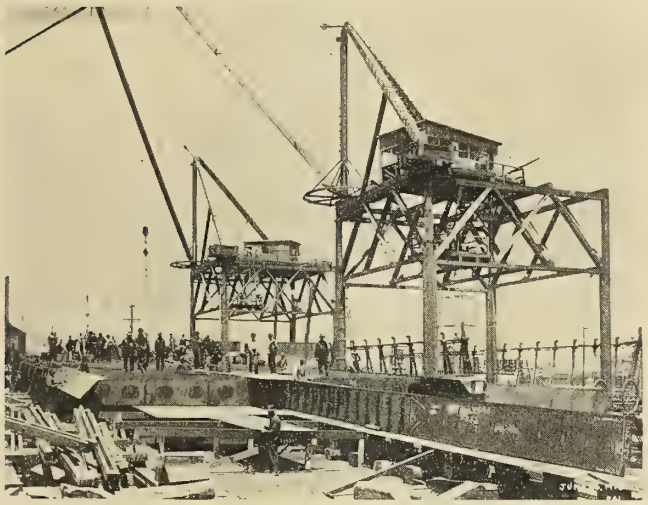
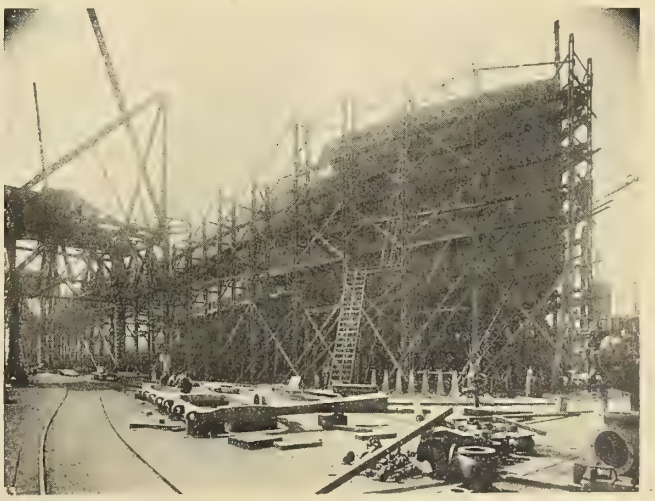


Fig. 6.—S.S. *Capto* Ready for Launching on October 14 at Moore & Scott Shipyard





Figs. 7-10.—Views Showing Progress of Construction of S.S. *Capto* at Moore & Scott Shipyard from June 26 to September 18

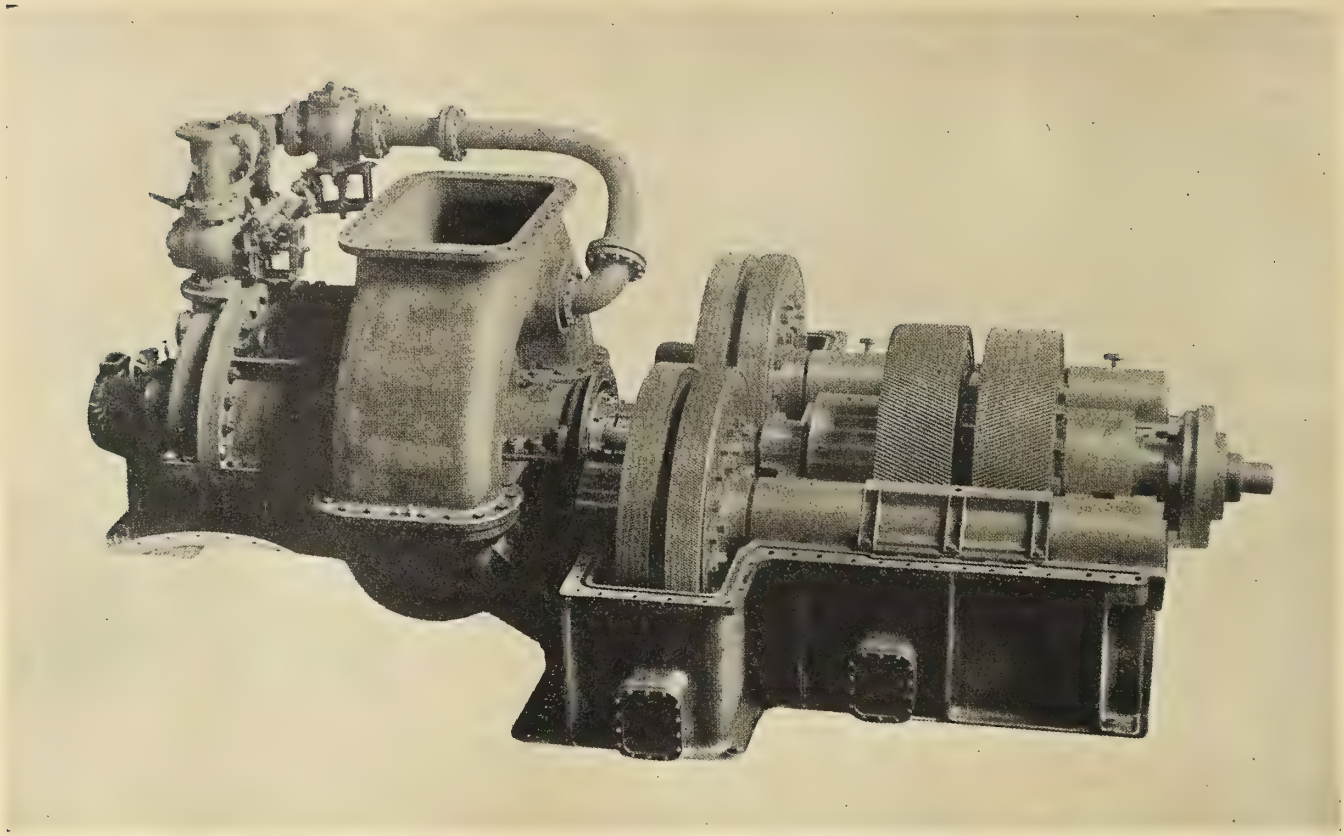


Fig. 1.—Curtis Turbine and One Plane Flexible Type Speed Reduction Gear for Ship Propulsion, Top Half of Gear Casing Removed

Alquist Gearing for Ship Propulsion*

Coustruction of Speed Reduction Gears Supplied by General Electric Company—Economics Effected in Service

BY W. L. R. EMMET

ALQUIST gearing has been applied to about seventy-two sets where steam turbines drive electric generators of various types. Contracts have been closed for machinery for the propulsion of seventy ships aggregating 215,200 horsepower. Some of these electric generating sets have been in service one and one-half years, and about seven of the ship sets are in service, some of them having made many long voyages. Among these are high pressure cruising units for the battleship *Nevada* which have been in service for some time and shown very fine results. Among the ship equipments not yet completed are included the propelling machinery for destroyer *No.* 69, built at Mare Island, and new propelling machinery for the scout cruiser *Salem.* In all of this practical experience no case of trouble with gearing has developed and no appreciable deterioration of gears has been observed.

One of the important reasons for adopting this type of gearing was that its design tended to afford a distribution of strains and means by which excessive strains would not be imposed upon any part through slight imperfections, distortions, or inaccuracies. The uniform success which has been accomplished with an entirely new product shows that this expectation has been amply justified. Some of the gears which have been used have been very imperfect, both in the matter of material and workmanship, and have been used under extremely trying conditions. That they have not failed has afforded the strongest evidence of the general reliability of the method.

The character of construction used in this gearing is shown by the drawings, Fig. 2. The gear is built up of a number of plates machined to a form which gives them the desired degree of lateral flexibility. These plates are put together, engaging solidly at the hub and also engaging on a narrow edge at the periphery. When so built together they form a solid cylinder which can be spirally cut in the ordinary manner. After cutting, the edge engagements are relieved with a small dividing tool so that each disk operates independently and is free to deflect latterly under the side pressure which results from its diagonal engagement with the pinion. The parts are so proportioned that this lateral deflection can at no time involve fiber strains which could possibly cause destructive fatigue. A very small amount of this lateral deflection is sufficient to afford the desired distribution of load, and this amount can easily be given without approaching dangerous periodic strains.

With gearing of the Alquist type we can use very small teeth without any danger of incurring excessive strains on individual teeth, which might involve risk of the development of fatigue cracks. In this connection it should be borne in mind that experiments have shown that the strongest steel, if subjected to periodic deflections, will

* From a paper presented before the Society of Naval Architects and Marine Engineers, New York, November 17

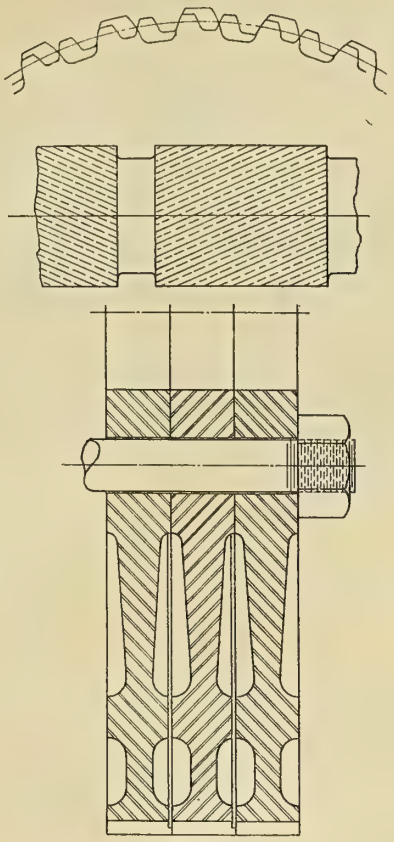


Fig. 2

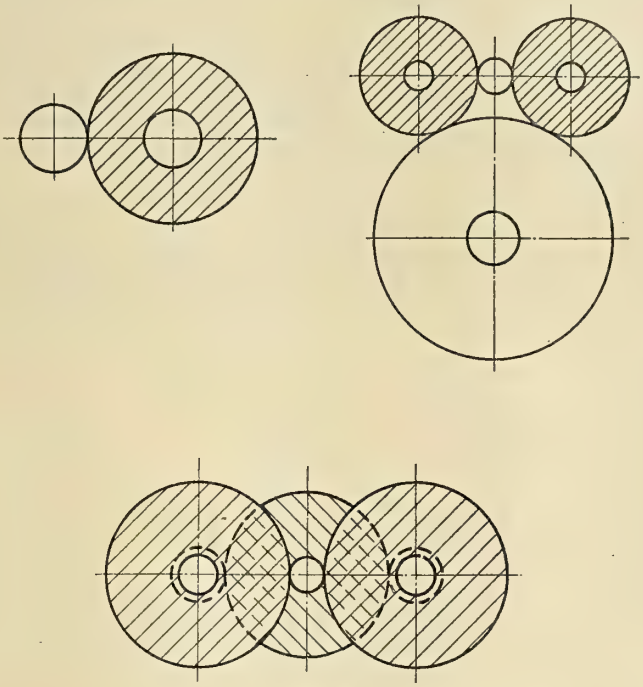


Fig. 3

break after a fiber strain of 20,000 pounds per square inch has been applied a million or more times.

In the work which is now being done by the General Electric Company, gears of the type described are applied in three ways. First, a single reduction has been accomplished by engaging one solid pinion with a flexible gear of this type; second, by engaging a solid pinion with two flexible idlers, which idlers in turn engage with a solid large gear; and third, in a double reduction where a solid, high-speed pinion engages flexible gears on two countershafts, these countershafts carrying solid pinions, both of which engage a flexible gear on the same low-speed shaft. In these two latter applications the flexibility of the gears serves to equalize the loads between all of the driving points, and the use of a plurality of driving points on the large gear reduces the length of face necessary on that

TABLE I.

S. S. "La Brea."

Voyage.	Date.	Total Distance in Knots.	Average Speed in Knots.	Total Barrels Delivered.	Name of Port.	Total Fuel Used Steaming on Voyage in Barrels.	Total Barrels Per Knot Steaming.	Total Barrels Used in Port.	Total Barrels Per Knot Steaming and in Port.	Time in Port Hours.	Barrels Discharged Per Hour.	Cost at 80 cents per Bl. Per Knot Steaming and in Port (Fuel.)	Shaft Horsepower Hours.	Pounds of Oil Per Shaft Horsepower
	1916													
1	March 9 to 15... ...	650	9.5	62,578	Oleum.....	574	.883	142	1.10	36½	1,714	$.88	116,000	1.67
2	March 15 to 26.....	2,037	11.33	73,600	Seattle.....	1,459	.716	152	.79	37½	1,962	.632	505,000	.941
3	March 28 to April 6..	2,108	11.01	64,676	Vancouver.....	1,584				26	2,487			
				8,642	Seattle.....	1,584	.751	155	.824	13½	640	.659	530,000	1.01
4	April 8 and May 16..	9254.5	10.97	52,109	Taltal Antofagasta	6,896				33¾	1,544			
				19,045		6,896	.745	117	.757	15½	1,228	.605	2,330,000	1.00
5	May 17 to May 23...	450	11.20	77,292	Oleum.....	321	.713	134	1.01	39	1,980	.808	118,000	.911
6	May 24 to July 1....	9196.5	10.65	71,824	Antofagasta.....	6,900	.75	109	.762	25	2,660	.609	2,200,000	1.06
7	July 1 to Aug. 9.....	9,184	10.39	71,791	Port San Luis to Antofagasta, Chile, and return.....	6,875	.748	107	.76	42.3	1,697	.609	2,230,000	1.04

Average speed 10.9. Total pounds of oil steaming = 8,270,000. Total shaft horsepower hr. 8,029,000. Pounds of oil per shaft hosrepower hour = 1.03.

S. S. "LOS ANGELES"

1	April 9 to 15.....	423	9.4	67,674	Oleum.....	556	1.31	164	1.70	64½	1,099	$1.36	74,600	2.48
2	April 16 to April 25..	1,345	10.13	74,739	Vamcouver.....	1,656	.897	218	1.01	33¾	2,214	.808	394,000	1.41
3	April 27 to May 25..	6,549	10.22	73,734	Panama.....	5,579	.851	169	.877	46¾	1,577	.701	1,420,000	1.315
4	May 26 to May 29...	220	9.1	72,372	Oleum.....	221	1.00	123	1.56	41	1,770	1.24	39,000	1.88
5	May 30 and June 27.	6,348	10.6	72,538	Bal-Boa.....	5,462	.86	159	.885	35	2,072	.708	1,460,000	1.255
6	June 29 Aug. 7, 16...	9,151	10.24	71,007	Port San Luis to Antofagasta, Chile, and return.....	8,293	.906	186	.926	56.3	1,261	.74	2,130,000	1.31

Average speed 10.27. Total pounds of oil steaming = 7,310,000 Total shaft horsepower hours, 5,538.000. Pounds oil per shaft horsepower hour = 1.320

Shipyard of the Peninsula Shipbuilding Company at Portland, Ore.

gear. These different methods of application are illustrated by diagrams in Fig. 3.

In both of these cases where a single high-speed pinion drives two flexible gears, other very positive advantages are accomplished. The pinion is relieved of bending strains, and pressure on the high-speed bearings is avoided.

Experiments have been made in Schenectady which carefully analyze the losses of high-speed gears under various conditions of load and pressure, and these experiments have indicated that low peripheral speeds are more efficient than high speeds. With solid gears low speeds involve difficulties because they diminish pinion diameters and increase pinion lengths, thus complicating the troubles which may arise through deflection and torsion of pinions and pressure upon pinion bearings. Since the flexibility of Alquist gears enables us to compensate easily for all possible degrees of torsional yield in the pinion, we can with such gears safely reduce peripheral speeds by making the gears longer and of smaller diameter. Such reductions of diameter diminish weight and improve efficiency, and the fact that the Alquist method makes such reductions possible constitutes one of its important advantages.

Table I shows a comparison of performances for two sister ships, the *La Brea* and the *Los Angeles*, operated by the Union Oil Company, of Los Angeles. Both of these ships are new, carry similar cargoes and burn the same fuel oil in the same boilers under similar conditions. The *La Brea* is fitted with our geared-turbine equipment, and the *Los Angles* is fitted with triple-expansion engines of the best type. The *Los Angles* is equipped with steam-driven, oil-handling pumps of the ordinary type, and the *La Brea* is fitted with a new arrangement of pumps driven from the upper deck by General Electric motors. The table illustrates the superiority of the oil-handling machinery as well as that which propels the ships. The horsepower-hours given in this table are calculated from the propeller and hull data given by the naval architect of the Union Iron Works, who built the ships, and based upon model tank experiments which were made in Washington. The models of the ships are identical, the *La Brea* propeller operating at 90 revolutions per minute, and that of the *Los Angeles* at 65 revolutions per minute.

The seventh voyage of the *La Brea* and the sixth voyage of the *Los Angeles* were made over the same course and at nearly the same time. The relation of fuel economy of these two voyages almost exactly corresponds to that shown by the average of all the voyages and tends to verify the accuracy of the whole comparison.

Peninsula Shipbuilding Company to Build Wooden Vessels at Portland, Ore.

With the recent revival of wooden shipbuilding in the United States, a number of new shipyards have been established in the Pacific Northwest on account of the abundance of shipbuilding timber available in that part of the country. The district in which this revived industry has largely centered is along the Columbia River in the vicinity of Portland, Ore. As Portland has more large sawmills than any other city in the world, and the state of Oregon contains one-fifth of all the standing timber in the United States, the building of wooden vessels in this district can be accomplished with a minimum of cost for the transportation of raw materials.

One of the latest companies to establish a shipbuilding plant in Oregon is the Peninsula Shipbuilding Company, which has a tract of land with a frontage of 3,100 feet on the Willamette River, and an average depth of 1,900 feet. The plant is equipped with a full cutting up mill, including band saws capable of tilting 45 degrees either way from a vertical line, air compressors for riveting, etc. A complete machine shop has been erected in which the machine tools are driven by electricity. Electric cranes are used for the delivery of material to different parts of the shops, and the plant draws a supply of Douglas fir timber from its own mills located within about 200 feet of the shipways.

F. C. Knapp, president of the Peninsula Lumber Company, is president of the new company, and the board of directors includes the following, all of Portland: A. L. Mills, president First National Bank; W. M. Ladd, president, Ladd & Tilton Bank; J. C. Ainsworth, president, U. S. National Bank; Peter Autzen, president, Peninsula National Bank; T. B. Wilcox, president, Portland Flouring Mills; J. C. Kerr, of Carey & Kerr, attorneys, and Mr. Knapp, president of the company.

MECHANICAL ENGINEERS' ANNUAL MEETING.—The annual meeting of the American Society of Mechanical Engineers will be held at the Engineering Societies Building, 29 West 39th street, New York city, December 5 to 8. The technical papers will be discussed in groups divided among the following subjects: Industrial Safety, Textile, Machine Shop, Valuation, Gas Power, Railroad, Steam Boiler and Miscellaneous. The annual address of Dr. D. S. Jacobus, president of the Society, will discuss the Relation of Education to Engineering.

Naval Architects' Annual Meeting

Twenty-Fourth General Meeting of the Society of Naval Architects and Marine Engineers—Abstracts of Papers Read

THE twenty-fourth general metting of the Society of Naval Architects and Marine Engineers was opened on Thursday morning, November 16, in the main auditorium of the Engineering Societies Building, New York City, with Mr. Stevenson Taylor, president of the society, in the chair.

The first business was the reading of the annual report of the secretary and treasurer, which showed that 808 members were enrolled in the society on November 1, 1916, as against 793 a year ago. According to the treasurer's balance sheet, the society's present worth on October 31, 1916, amounted to $30,788.48 (£6,300).

The following deaths were recorded during the year: David Almy, James M. Lincoln and William A. Perry (members), and Ralph D. Williams (associate).

In accordance with action taken by the Council, President Taylor brought before the society a suggestion submitted by Mr. T. M. Cornbrooks during the summer to the effect that a permanent committee be appointed to represent the society at public hearings regarding matters that come within its scope, or on other occasions where the advice, experience and scientific knowledge of the society as a body would be of value to the public. The society voted to authorize the executive committee to appoint such a committee.

The names of 77 applicants for membership in the society were read by the secretary and their election was duly ratified by a unanimous vote of the society.

The following officers were elected for the terms specified:

Vice-presidents for term expiring December 31, 1919.—R. M. Watt, A. P. Niblack, W. M. McFarland, J. W. Miller.

Members of Council for term expiring December 31, 1919.—C. P. Wetherbee, J. H. Linnard, C. A. McAllister, W. L. R. Emmet, J. H. Gardner, H. C. Higgins.

Associate members of Council for term expiring December 31, 1919.—R. A. C. Smith, Albert W. Goodrich.

Executive committee for year 1917.—W. L. Capps, F. L. DuBosque, W. I. Babcock, Andrew Fletcher, W. M. McFarland.

Committee on papers for year 1917.—W. M. McFarland, F. L. DuBosque, W. I. Babcock.

Secretary-treasurer for year 1917.—Daniel H. Cox.

The president then delivered his annual address, extracts from which will be found on page 523 of this issue.

The following papers were then read and discussed:

New Method of Indicating the Density of Smoke as Installed on the U. S. S. Conyngham

BY REAR ADMIRAL R. T. HALL, U. S. N.

ABSTRACT

This system, installed on the after stack of the U. S. S. *Conyngham*, consists of a light transmitter installed on one side of stack, a light receiver installed on opposite side of stack to light transmitter, and an indicating meter with suitable control appliances installed in boiler room. The indicating meter is provided with a scale of smoke densities, ranging from dark to clear.

This system was in successful operation during the official trial of the vessel and was found to operate satisfactorily under all conditions of smoke.

Scale indications at various densities of smoke were checked up by a member of the trial board with observations made visibly from deck, and were found to be correct.

The basic principle of operation of the system is dependent on the peculiar property of the metal selenium, which, under certain conditions of crystalline structure, is light sensitive in its resistance to a passage of electric current, viz., of low resistance at higher light intensities, and vice versa of high resistance to lower light intensities.

It will be manifest, if a beam of light be projected across a stack, that its intensity will vary with the density of the smoke. It will be further manifest, if a plate of selenium of suitable structure is placed opposite to the source of projected light, its electrical resistance will also vary with the density of smoke, and, by connecting the selenium plate in series with a suitable indicating meter and a source of electric current supply, such variations of smoke density will be made manifest by variation in current flowing through meter and, by suitably arranging the meter scale, such variations in electric current will be indicated as smoke densities.

On a metal plate installed in the boiler room, in a location readily observable by attendants, is installed the smoke indicating meter and a potentiometer, which is provided with a slidable brush for adjusting the potential on the selenium plate, and serves as a simple and effective means for setting the indicator on the clear indication, as when no smoke is issuing from stack.

The system is connected to the ship's lighting battle main at 125 volts.

The following general advantages are claimed for the system:

(*a*) Making it possible for attendants in boiler rooms to observe directly the character of smoke issuing from stack and enabling them to adjust the amount of fuel and air necessary for perfect combustion.

(*b*) Prevention of soot deposition on heating surfaces, such soot impairing the evaporative efficiency.

(*c*) Informs firemen of smoking condition of stacks and serves as a means for elimination of the many objections to same.

(*d*) Elimination of personal error from a naval strategical standpoint in determining smoke densities. At present the recording of smoke densities is dependent on the human vision in comparison to arbitrary shades and colors.

Salvage Equipment Used in Raising Submarine F-4

BY NAVAL CONSTRUCTOR J. A. FURER, U. S. N.

ABSTRACT

The United States submarine *F*-4 failed to return from a submerged run made outside of Honolulu harbor on March 25, 1915. The vessel was definitely located on the following day in 304 feet of water. After making a number of fruitless attempts to drag the submarine into shallower water by means of sweeps, it became apparent that direct lifting was the only practicable salvage method.

The problem consisted of lifting 260 tons, the submerged weight of the submarine. Briefly, the salvage method consisted of sweeping four wire hawsers under the vessel—two forward and two aft. The ends of these hawsers were brought up through the central mud-pocket

openings of two bottom dumping mud scows, each 104 feet long by 36 feet beam by 13 feet deep, and were then attached to specially constructed windlasses mounted over the pockets. Two windlasses were installed on each scow, one for each hawser. By winding up the hawsers on these windlasses the vessel was thus lifted in the loops of the four slings. Power was supplied on each scow by a two-drum, 8-inch by 10-inch hoisting engine.

In order to provide a margin of reserve power for starting the vessel provision was made for using the buoyancy of the scows. A flood valve was fitted in the bottom of each scow and pumps were installed on deck for unwatering. Stability calculations indicated that the scows would be unstable with the load suspended from the windlass shafts because of the internal free water surface. In order to counteract the upsetting moment due to the negative metacentric height under these conditions, should it become necessary to flood the scows, heavy timber cribbing was fitted around the bottom of the mud-pockets for restricting the swing of the lifting hawsers. This timber cribbing also served the purpose of protecting the structure of the scow itself from the cables.

Six cables as follows, each from 900 to 1,000 feet long, were used for lifting at one time and another—one 2⅝-inch plow steel, one 2-inch plow steel, two 2½-inch galvanized crucible steel, and two 2¼-inch galvanized crucible steel hawsers. The two plow steel hawsers, especially the 2⅝-inch hawser, proved the most satisfactory, because they resisted chafing to a much greater degree than galvanized wire. On the other hand, the plow steel cables were much harder to handle and to sweep because of their stiffness.

A dredge equipped with an adequate power plant, including a dynamo, was used as a base for conducting the salvage operations. As the dredge could not be moored in the customary manner on account of the great depth of water to seaward, the expedient adopted was to use the submarine itself as the seaward anchor. This was accomplished by sweeping a wire hawser around both the bow and the stern of the vessel.

Plain wire hawsers of the sizes mentioned were first used for lifting the submarine. These hawsers were swept under the vessel by tugs. Divers were sent down after each line was swept into place to report on its position.

The diving on this job established a new record. On this job the men were not kept on the bottom intentionally more than from ten to fifteen minutes at a time. It was fortunately not found necessary to call on the divers to do manual work while the vessel was in deep water. Their function consisted of observing the location of the lines and reporting on the steps necessary to bring them into the positions desired.

After lifting the submarine about 12 feet and towing inshore a corresponding amount, one of the galvanized hawsers parted. On being brought to the surface it was quite evident that the stranding had occurred at the bilge keels. Its replacement was somewhat delayed by the weather, but this was finally accomplished and another lift was made. A hawser again parted and could not be immediately replaced on account of bad weather. While the scows were riding out the weather, one cable after another parted, the last to go being the 2⅝-inch plow steel cable. Altogether a lift of 25 feet was accomplished with the wire hawsers.

In view of the rapid impairment of the cables by chafing, a 15-fathom shot of chain was next inserted in the middle of each sling where it passed under the submarine. After working twenty-one days all four slings were again in place and lifting operations were resumed. Good progress was made in hoisting and towing to shallower water. A depth of 50 feet was reached close to the harbor entrance, when a heavy ground swell and bad weather set in very suddenly and wrecked the whole operation.

On taking into consideration various phases of the situation it was decided, on account of heavy weather, to change the plan of operations. The strongest reason, however, for changing the salvage plan was that the submarine might break in half while being taken through the channel, if lifted by the scows. This would have blocked the harbor to navigation, as there was no water shallower than about 40 feet in which the vessel could be landed, it was necessary to resort to a salvage method which would provide for lifting the vessel from a depth of 50 feet to a depth of not more than 25 feet at one step.

The use of submersible pontoons offered the best solution of the problem. The plan adopted called for the use of three pontoons on each side of the vessel connected in pairs by chains passing under the boat and up through hawse pipes in the pontoons. Four of the pontoons—the bow and stern pairs—were made 32 feet long by 11 feet in diameter. The other two were made the same length, but were 12 feet 6 inches in diameter. The buoyancy—that is, the lifting capacity—of the 11-foot cylinders was 63 tons, and, of the larger cylinders, 84 tons. The combined lifting capacity of the four pontoons was 420 tons. This provided excess capacity of 160 tons over the estimated weight of the submarine.

Securing the pontoons to the submarine was one of the most important features of the salvage arrangement. Chains were rove under the vessel and, while the pontoons were afloat, were brought up through the hawse pipes already mentioned. After the pontoons had been landed on the bottom, cast steel clamps were bolted around the chains just above the hawse pipes.

Compressed air taken from torpedo air flasks was used for unwatering the pontoons.

The work of passing the chains under the vessel took three working days, with a few intervening days when the swell and undertow were so heavy that divers could not stay on the bottom. The job of substituting the coal lighter, with its equipment of air flasks, for the wrecking barge was completed on Saturday, August 28, too late to unwater the pontoons on that date. The final work of connecting up the hose leads to the pontoons and opening the discharge and blow valves was started at daybreak on Sunday, August 29.

When all necessary preparations had been made a diver was sent down to watch the pontoons and to report by telephone as they became buoyant. The air was first started on all four compartments of the stern pontoons. When this pair was buoyant the air was shut off and the middle pontoons were started off the bottom in the same manner. In the case of the bow pontoons it was necessary to bring the forward end of the seaward cylinder off the bottom in advance of the after end in order to clear the bow rudder on this side, which was still in place and projected upward at an angle of about 45 degrees. If this precaution had not been taken the pontoon would have jambed against the sharp point of the rudder and would probably have sprung a leak. The pontoons were all partly unwatered before turning on the air to all six cylinders, in order to make certain that all the lines and discharge valves were functioning properly.

When the pontoons had in turn been brought to a reasonably horizontal position by manipulating the manifold valves, air was turned on to all twelve compartments. One end of the submarine came up slightly ahead of the other, as was inevitable.

Once the pontoons emerged they immediately adjusted

themselves automatically, as the high ends ceased to be water borne, and therefore exerted no pull on the chain. This permitted the buoyancy of the low end of the opposite pontoon to assert itself, thus causing the chain to render.

Discussion

Captain A. P. Niblack, U. S. N., pointed out that while other nations have provided special salvage vessels for work of this kind, the United States has not followed this custom because of the extent of our coast line and the distance apart of our naval bases. Hitherto the handling of our submarines has been rather disconnected, but the naval board is now considering the establishment of additional submarine bases, and it is possible that this might lead to the provision of special submarine salvage vessels. Captain Niblack also pointed out that the splendid work of the divers in salving the *F*-4 demonstrated the efficiency and usefulness of the diving school conducted by the navy for many years and now located at Newport, R. I.

Naval Constructor Furer stated that the salvage of the *F*-4 was the best demonstration that a special type of submarine salvage vessel is not a good investment. In this case the salvage operations cost about $125,000 (£25,600), which represents only a small proportion of the cost of a salvage vessel, and to meet the requirements of the United States navy, at least four such vessels would be necessary. The important problem in raising the *F*-4 was in getting shackles under the boat and not the application of power in raising the vessel. The question of speed in salvage operations would be of importance only in case of saving lives.

The Design of an Oil Engine

by John F. Wentworth

Abstract

The type of engine selected was a four-cycle oil engine designed for naval use to fill the following conditions: Brake horsepower, 450; revolutions per minute, 450; length overall, not to exceed 14 feet 9 inches; width, not to exceed 3 feet 8 inches; height above center of shaft, not to exceed 6 feet; distance below center of shaft, not to exceed 23 inches; weight, not to exceed 26,000 pounds. To meet the conditions a six-cylinder engine was designed with cylinders of 13 inches bore by 12-inch stroke. The compression at full load was fixed at 200 pounds per square inch. In this respect the engine presents a radical departure from the Diesel type of heavy oil engine, in which the pressure of compression is usually about 500 pounds per square inch.

The engine is divided into two sections of three cylinders each with the couplings, reverse gear and fuel pump placed between the two sets of cylinders. While the fuel and admission valves must be subject to regulation as to timing, etc., and the starting and exhaust valves do not need this regulation, the fuel and exhaust valves are placed on the front side of the engine and the starting and admission valves on the back side.

For starting the engine it is proposed to use steam instead of compressed air, steam being admitted to the water jackets of the cylinders to reduce condensation of the steam in the cylinders. As soon as the engine is firing on oil the jackets are to be filled with water and the engine will then follow the conventional Diesel type in its cycle. For supplying steam for this purpose the author proposes a special type of boiler fired by oil fuel when the oil engine is not in operation and heated by the exhaust from the engine when the engine is in operation.

The paper gives a detailed description of the cam gear for operating the valves as well as of the mechanism for reversing the engine. The fuel is fed to the engine by a fuel pump of novel design. Instead of a slow-moving pump plunger, the fuel pump is fitted with a floating piston, which is lifted in the delivery stroke by a lever operated by a cam. The plunger is returned by springs at the bottom of the plunger and is at all times kept against the lever by means of the spring. The motion of the lever determines the stroke of the plunger and the movement of the lever is controlled by an eccentric shaft. With full eccentricity of the shaft up the lever is held so that the cams clear and no fuel is delivered. With the shaft turned an angle of 180 degrees, the maximum stroke of the plunger is obtained. Any desired position may be obtained for the shaft between these two extreme positions, and so the amount of fuel delivered may thus be governed. The feature of this pump is not only to deliver exactly the fuel required, but to deliver this particular amount and at just the moment it is needed. By varying the position and this setting of cams, the action of the fuel pump may have a different timing.

The fuel valve is also of novel design, being a double valve. The air for injection has one seat and the fuel goes through another seat. The lift of the fuel plunger should be timed to act with the opening of these two valves, so that the fuel will be delivered by the pump directly into a stream of moving injection air. In this valve the fuel starts after the air has started and stops while the air valve is still open. The result is that the fuel valve should give no trouble with clogging, as it is cleared by air after each delivery stroke. A fuel heating tank is supplied in which the fuel is heated by means of a coil of steam pipes within a tank.

Aeronautics in Relation to Naval Architecture

by Naval Constructor H. C. Richardson, U. S. N.

Abstract

Early in 1911 work was started at the model basin at the Washington Navy Yard, with a view to the development of floats for aeroplanes. This work has been constantly followed up by making tests of model floats of all descriptions, and particularly with models of floats actually furnished, or proposed, for use with naval aeroplanes. In addition to this, series of models embodying variations of particular features were tried from time to time, covering a wide range of possible useful features, and, where such models showed sufficient merit, full-size construction has been carried on, and the full-size floats have been given tests in actual service. A detailed account of the complete series of tests would be too voluminous for reproduction, and would cover many defective types, so the paper enters only into a general discussion of types and the requirements for floats for naval aeroplanes.

The principal differences existing between the conditions of use of aeroplane floats, and those met in the use of ordinary displacement vessels, or vessels of the hydroplane type arise from the fact that as the square of the speed increases the lifting power of the wings becomes more and more important, and the load carried by the aeroplane float constantly diminishes until at the get-away speed no load is any longer carried by the float. At the higher speeds near the get-away conditions, the form of the bottom of the float becomes unusually important, due to a prominent suction effect which is present if any downwardly bowed lines of flow are presented.

Many forms and dispositions of floats have been proposed and tried, and for inland waters several successful

forms now exist, but for work in the open sea no form is yet known to have all the required qualities.

The first success was attained by Curtis with floats of an exaggerated blade form, but these were not as satisfactory as the normal rectangular section float having a skidform profile. This is a simple and successful form for inland work, and it seems to matter little from a resistance point of view what form of bow curve is used. Close agreement was found in performance of bows having widely different forms of curvature. Various other forms of bows were tried—convex, concave, flat sloping bows, corrugated bows—and all show essentially the same characteristics.

The influence of steps has been tried—one, two, and up to six. From a resistance point of view it appears unnecessary to provide more than two steps for aeroplane conditions. The first break is usually placed nearly under the center of gravity, and the second forms the stern of the float. If both steps are inclined in the same sense a biplane float is formed, but if the after step rises relative to the forward one, it more nearly approaches the monoplane or single-step form, which has desirable qualities. This is the form which has proved so successful in the flying boat. Ventilation of the steps facilitates quick planing and is useful, but is not essential if there is ample reserve of power.

Interference between twin floats at the separation usual in practice appears inappreciable, except at very low speeds.

Flat-bottom floats pound heavily and the flat-bottom-step type porpoises strongly unless it is handled very nicely, even in smooth water.

The introduction of a moderate V-bottom greatly reduces the shock of landing on smooth or rough water. All straight V's throw a strong sheet of spray at the bow. This sheet of spray appears to be independent of the true bow wave. It can be suppressed by the use of hollow V-lines at the bow, but this form is difficult to build strongly and has bad steering tendencies when trimmed by the bow or when making a skidding landing or get-away. A simpler method of suppressing this bow spray is the use of mud guards, so-called for obvious reasons.

The V-bottom also greatly reduces the danger of sticking a wing under on a skidding landing, or when running at high speed across the wind.

The use of fine lines at the bow or stern is not very general, because of the need of longitudinal stiffness. Such lines steer badly, and there is some evidence of the suction effect being present. It is not improbable, however, that a compromise between such lines and the V-bow may work out in solving the seagoing problem.

In construction details in this country the boat-builders' influence is just being asserted. The principal builders have followed a box-like construction not disposing of their material to advantage. In recent efforts to develop a stream-line form of float, the general form is as nearly stream line as practicable, having a curved deck comprised of two-ply spruce, applied diagonally, one across the other, with cotton sheeting and marine glue between the plies. This construction eliminates the usual deck joints and provides the arched form with diagonal bracing, continuous from chime to chime.

Through the center of the float a longitudinal truss provides the backbone of the construction. Two-ply bulkheads support the float attachments, and the principal bulkheads are tied to each other and to the step by a two-ply fore-and-aft bulkhead built into the center-line girder. These bulkheads are bound by oak ribs and intermediate ribs of oak support the top shell.

The bilge stringers and the keelson are continuous, the step being formed by tapered liners. The step is of oak, as when grounding, or when planing at high speed, the loads are concentrated at the step. The bottom is two-ply spruce, the inner ply running athwartships and the outer ply running diagonally outboard and aft from the keel to the bilge stringers.

Cotton sheeting and marine glue are used in all two-ply work and the plys are held together by special clinch nails of brass.

The bottom is supported by the keel and bilge stringers and an intermediate longitudinal, which are in turn supported by the step and bulkheads. The stem and stern pieces are of spruce, shaped to take the longitudinal members and rabbeted to receive the shell planking. The system of bottom planking and longitudinals eliminates the use of bottom frames and really provides continuous framing in the planking itself, similar to Hands' original V-bottom construction. This type of bottom planking appears resilient and strong.

In assembly all butts are covered with glue. All woodwork is given two coats of shellac as soon as it is in place, and is finally given two coats of varnish to prevent the absorption of moisture.

All boundaries of the bottom are sheathed with brass strips set in marine glue. This affords protection and insures watertightness. The float attachments are locally reinforced and strengthened to transmit the loads to the important members.

Each of these floats, designed for 1,000 pounds displacement and 60 percent reserve buoyancy, weighs, complete, 125 pounds. The principal dimensions are: Length, 15 feet; maximum beam, 24 inches; maximum draft, 14 inches.

The floats have been used in service with very satisfactory results. The aerodynamic properties of these floats are good. They have the least resistance when the deck is inclined at —3 degrees to the wind, and in this position have no lift; consequently, they present a minimum disturbance in the equilibrium of the aeroplane.

Discussion

Mr. Elmer A. Sperry emphasized the difficulties which this problem presents, citing the case of the hydro-aeroplane *America*, which, while a successful flyer, was hard to get out of the water. It was found that a flaring bow helped in breaking the bow waves, allowing the boat to rise. While rectangular floats separate easily from the water they are not suited for use in rough water. It is of the utmost importance to secure a seaworthy boat that will separate itself from the water.

The Power-Forging of Chain Cables

BY NAVAL CONSTRUCTOR FREDERIC G. COBURN, U. S. N.

Abstract

There has been developed during the last two years at the United States Navy Yard, Boston, Mass., a power-forging process for the manufacture of chain cables which has been highly successful. No great mechanical difficulty was experienced in the manufacture of chain by hand until diameters as great as 2¾ inches were reached; even that size was fairly well handled; but when the 3-inch cables were taken up serious difficulties were encountered on account of the size of the metal, the mechanical difficulties involved and the very hard labor required of the chain makers' helpers. It was not only difficult to get chain makers to make a good chain; it was ex-

ceedingly difficult to get them to attain a satisfactorily high rate of production and regularity of attendance.

The causes of the inferiority of hand-made welds become apparent after experience in the testing pit. The helpers cannot hit hard enough with their sledges to drive the two scarfs together. The welding surfaces are not smooth, because they are formed by peening; pockets are thus formed, which retain slag; and the hammering does not work out this slag. Thus the weld is incomplete. Sometimes a pocket as big as a half-dollar is found, occasionally open to the sea by a small crevice. Fractures have been produced in proofing old chain which showed that not over 10 percent of the surfaces was welded; only the strength due to form, assisted by the tacking together of the scarfs, had held those links intact in service.

In the large chain it was impossible to finish the inside of the link at the welded end, thus leaving a hollow and reducing the sectional area.

Another serious defect in the hand-welded chain is the wasting of the material, in the fire, just back of the weld. There is no way to make this up except to increase (uniformly) the diameter of the metal in order to have the full diameter in this quarter. In the power-forged link, however, the metal is upset slightly before scarfing, completely avoiding this deficiency.

To sum up, the hand-made welds are not complete, not uniform and not reliable. The need of a power-forging process was therefore apparent.

The first attempt was made with a Bradley helve hammer, because that hammer hits a rapid, elastic blow, which appeared to simulate the blows of the hand sledge. That method was found impracticable, and resort was then had to ordinary steam hammers. All the experiments had been made on the 3-inch size, and at the time referred to there were available the dies that had been made for the purpose. Briefly, the process consisted of shearing the bolt to length as usual for the hand-welders, in a large power shears; bending up the end of the bolt in a 6-inch Ajax upsetting machine; putting on the scarf in a 2,500-pound steam drop hammer; bending the link by hand around a mandrel; welding the link under a 350-pound, single-frame steam-forging hammer; and then, in another heat, finishing the link under dies fitted to a 3,000-pound, double-frame forging hammer; trimming off the "flash" by hand.

While this process made chain that looked good, it would not meet the breaking stress requirements. Consideration was then given to the possible benefits of heat treatment, and the practice now is to give the chain an air quench from a temperature slightly above the upper critical point.

The equipment in use at first was, of course, more or less improvised; and during the past two years there has been a constant, almost daily, development in the equipment and its use. New hammers, especially designed for this service, have been purchased, and have proved highly satisfactory in service. The methods of heat treatment have been vastly improved. Standard thermocouples have been manufactured and installed; potentiometers purchased, to use instead of galvanometers, and the use of the equipment studied, with the result that in the large, car-bottom, over-fired, chain-annealing furnace, where finished chain is treated, nine thermocouples are installed, and it is found practicable to keep the temperature variation, between different parts of the furnace chambers, within 10 degrees C.

During the fiscal year ending June 30, 1916, there were manufactured at the Boston Navy Yard practically 9 miles of chain of diameters 2¼ inches to 3⅜ inches, inclusive. No better confirmation of the statement that the problem has been solved can be asked for. The cost of 3¼-inch chain, for example, has been practically $6 per foot, or $0.06 per pound. Even this cost is considered high, because the process is not yet wholly beyond the experimental stage; that is to say, that a very great improvment will be made, probably in the near future, in the methods of bending the link, in trimming the link after welding, and in other directions, so that the cost will shortly recede to a considerable extent. Even if the cost were greater for properly made and welded chain, it would be offset by the gain in amount and regularity of production and in quality.

When the 3-inch, open-link chain for the Panama Canal was being manufactured, the cost per link, direct labor, ran about $1.37 by hand, and about $1.20 by power. The job was wound up so quickly that there was not time to bring about cost reductions; but on 3-inch, stud-link chain made for the Commission the figure of $0.86 was attained. This was subsequently still further reduced.

A brief description of the process, illustrated by photographs of the machines and their operations, is given in the paper.

It is interesting to note the economic significance of this power-forging process of making chain, as it is an excellent illustration of the division of labor which always results in the application of power for operation. Where one gang performed the operations of scarfing, bending, welding, finishing, etc., it was impossible to substitute a machine for the gang. But when the process was divided into its integral parts, then it was found that each little part was a simple one, to be done over and over again, and lending itself to the application of power. It has also this significance—that where the hand-welding process required a high-grade mechanic on each operation, this process required a high-grade mechanic on only one operation—that of welding—the other operations are so simple that a helper can be used, the helper being carefully taught the particular part of the process that he will have to perform. For example, the shearing of the bar is done by a helper; also the bending of the links is done by helpers; the upsetting and scarfing operations are performed by fourth-class mechanics, who were helpers and who have been trained to do this particular work. They were rated from helpers because the work is somewhat above that which would be normally expected of a helper.

Description and Trials of the Turbine Steam Yacht Winchester

BY E. A. STEVENS, JR.

This paper will be published in extenso in the January issue.

Discussion

Mr. E. H. B. Anderson called attention to the extreme simplicity of the machinery on this vessel. Very few auxiliaries are needed. The circulating pumps are not used when the vessel is under way, the circulating water for the condenser being supplied by scoops under the vessel, thus saving in the steam consumption of the auxiliaries. Another saving is made by arranging the turbine-driven blowers in the fireroom in series. The fuel consumption at a cruising speed of 19.7 knots gives the vessel a radius of 2,000 miles on the oil fuel which she carries.

A Theory of Fluid Friction

BY WILLIAM GATEWOOD

Abstract

The subject of fluid friction has received a great deal of attention, and empirical formulæ are in general use in connection with the flow of water, air and other fluids in

closed pipes, and with the flow of water in open channels. We have empirical formulæ also for determining the frictional resistance of vessels, derived from an analysis of experiments on flat boards. Until very recently, however, very little progress has been made in checking the accuracy of the assumptions made in extending the results of these experiments to higher speeds, greater lengths and ship-shape forms.

It seems that the reason why our knowledge of frictional resistance is so uncertain is due to the fact that there is no generally accepted theory of fluid friction. This paper is an attempt to correlate the laws of fluid motion which seem to have a bearing on the subject, and to formulate a theory.

The theory may be summarized as follows:

1. Frictional resistance per unit of surface varies as the square of the equivalent rubbing velocity determined by considering the flow to be laminar.

2. Friction between adjacent laminæ of the fluid varies as the rate of change of velocity occurring at their boundary.

3. In the case of a fixed body and a moving fluid, the frictional resistance experienced up to a given distance abaft the cutwater must be balanced by the loss of head in the wake at the same distance abaft the cutwater.

4. The width of the wake at a given distance abaft the cutwater and the reduction of velocity in the wake at various distances from the fixed body may be determined by the consideration that the loss of head outboard of any lamina is equal to the frictional resistance experienced by the lamina before reaching the given distance from the cutwater.

5. The determination of the loss of head in the wake is complicated by the condition that the volume of the fluid passing the fixed body is not altered, although the velocity in the wake is decreased. The consequent elevation of the surface of the fluid becomes of considerable importance when the velocity is relatively small or the reduction in velocity occurs quickly on account of roughness of surface.

6. The energy and action of the eddies may be assumed to be such that the loss of head may be determined as though the flow were entirely laminar.

In conclusion, it may be noted that laminar flow in the open seems hardly in accordance with all the facts as observed, since the friction of wind on water produces *waves*.

Discussion

Mr. W. L. R. Emmet described experiments which he made twenty years ago with a 25-foot toboggan boat, which he towed in a canal at speeds up to 31 miles per hour, recording the tow line pull and speed. At a speed of 15 miles per hour the waves ceased and then only friction resisted the boat, but the coefficient of friction was found to differ from that given in text books on naval architecture. Believing that this was caused by the introduction of air between the boat and the water, he suggested that possibly air might be introduced under a vessel forming foam, which will shear more easily than water and thus reduce the skin friction.

Mr. F. B. Smith called attention to the exceptional speeds obtained with lake freighters in light condition, due, he believed, to the change of trim by the stern when the vessel is under way, giving a planing effect to the flat bottom of the boat.

Notes from the Model Basin

BY NAVAL CONSTRUCTOR WM. MC ENTEE, U. S. N.

This paper is published on page 530.

Discussion

Professor H. C. Sadler called attention to the fact that these propeller experiments explain why two propellers of the same design give entirely different results. He hoped that further investigation would be made of the wind resistance of vessels.

Professor C. H. Peabody stated that while these experiments show in a marked way the results of roughness of propeller blades, they do not show the degree of loss of efficiency. They do show, however, the great advantage of having propellers finished.

Naval Constructor Gatewood suggested that a curve on the basis of thrust, showing the increased efficiency of smooth propellers, would be desirable.

Illustrated Lecture on Submarines

At the close of the Thursday afternoon session an illustrated lecture on Submarines was delivered by Mr. Eric H. Ewertz, superintendent of the Fore River Shipbuilding Corporation, Quincy, Mass.

Military and Technical Consideration of Battleship Design

BY NAVAL CONSTRUCTOR R. D. GATEWOOD, U. S. N.

This paper will be published in the January issue.

Discussion

Captain W. Hovgaard pointed out the importance of the speed-armament gage as exemplified in the present war. While there is a limit to the size of ships in the smaller navies, the limit has not been reached in vessels of the United States and other large navies. In discussing the question of size as compared with risks, he expressed the belief that risks in peace and war favored large ships rather than a greater number of smaller vessels; for in ordinary service the greater the number of ships the greater the chance for damage; while in war, although the larger ships will receive concentrated attack, they can be better safeguarded and protected. The danger from mine attack is the same for large as small vessels.

Captain A. P. Niblack stated that the size of gun depends on how far the fall of projectiles can be spotted. It is easy to exaggerate the importance of the long range of guns, because it is useless to shoot further than you can see. The matter of speed becomes a strategic question.

Professor Hovgaard stated that extreme speeds are relegated to battle cruisers, but advocated somewhat higher speeds than have been used in United States battleships before. He pointed out that on long ranges the heavier guns are more effective.

Naval Constructor R. D. Gatewood pointed out that not only can better protection be provided with large vessels, but four destroyers will be equally effective with large or small battleships, so that if there is a large number of small battleships there must be a correspondingly increased number of auxiliaries, such as destroyers, etc. He also pointed out that the 16-inch gun gives greater dispersion and that a 16-inch shell will do about one-third more damage than the 14-inch shell.

On the Suitability of Current Design of Submarines to the Needs of the United States Navy

BY CAPTAIN W. L. RODGERS, U. S. N.

Abstract

The purpose of this paper is, first, to examine the peculiar military characteristics of submarines in general and compare them with those of other types of combatant ships; second, to consider how these general characteris-

tics will influence or control the employment of submarines in war; and, finally, what particular types of submarines seem best suited to American needs.

Submarines are armed with torpedoes and with guns. Owing to the great percentage of the displacement which is necessarily devoted to the heavy hulls and very heavy machinery installation, the speed of submarines is much less than that practicable for surface craft of the same size. Consequently submarines, unlike torpedo boats and other fast craft, cannot rely on their speed as a means of safety. For the submarine the chief means of defense is provided by her submersibility and consequent invisibility. Further, the great weight of storage batteries forbids giving submarines more than a small radius of action when submerged. As the submarine when submerged cannot hope to overtake its target it must lie in wait for the target to come to it. Thus the submarine is not only an arm to be used by stealth, but its most favorable opportunities occur in dispersed and solitary action rather than in concentrated and co-ordinated action.

Until the outbreak of the current great war there seemed to be no adequate defense against submarine attack, but necessity is the mother of invention in tactics as well as in material, and there is less to fear from the submarine now than at the outbreak of the war. The great ships which the submarine would most gladly meet find their best protection is rapid motion; for the slow submarine, seeing imperfectly, is disconcerted by swift movement, more especially if this is accompanied by frequent alterations in direction. But ships cannot be always on the move and it is necessary to provide both passive defense and active counter-attack against submarines. For harbors and certain sea areas the passive defense is furnished by wire nets whose meshes are of a size suitable for catching submarines, while the counter-attack is made by thousands of swift patrol boats whose business is to destroy the submarine or force him down again whenever he comes to the surface for information or for air to start his engines and to recharge his batteries. The success of these measures against submarines is undeniable.

By a line of *a priori* reasoning the general broad conclusion to be drawn is that the submarine is essentially a defensive arm, whose use as an offensive arm, although practicable, yet partakes somewhat of the nature of a *tour de force*. So far as we know, submarines have accomplished little or nothing during the current war when acting in company with the main fleets. At the battle of Jutland last May they seem to have been absent or ineffective. The evidence of the present war as to submarines may be summarized by saying that on both sides they have obtained a degree of success in defense, to the extent of forbidding the approach of the main fleets of both sides to hostile coasts. In this successful coast defense submarines have been greatly aided by mines. The use of submarines for the purpose of strategic attack has been less successful, although Germany's attack, in particular, has arrested much attention. While the destruction of commerce has been serious, it has not led to conclusive results, although the narrow waters in which this contest has taken place have been favorable to the efforts of submarines because commerce has been obliged to cross the areas infested by them.

The geographic situation of the United States, with a very extended coast line, much of which is remote from possible enemies and borders great oceans, is very different from that of the present combatants, who are separated by comparatively narrow waters and confront each other at relatively short ranges. As we have seen, the submarine is essentially a defensive arm. It finds least opportunity when it meets its enemy in the open sea with full freedom for maneuver. On the contrary, the submarine is favored when its enemy approaches a hostile shore, where his freedom of maneuver is hampered by the proximity of the coast and his advantage of speed is thereby partially counterbalanced.

Therefore, it does not seem desirable that our navy should attempt to establish a defensive cordon of submarines far from our coasts in mid-ocean. For a line held there will be long; its distance from shore will require much time to arrive at and return from station, necessitating excessive numbers of ships. The enemy has no objective in mid-ocean and will not wait there. If he is attacked in that neighborhood by submarines he has the advantage of full opportunity to maneuver freely at high speed. On the other hand, our submarines will gain on every one of the above-mentioned points if they are used for local coast defense and do not go far off shore—say not more than a day's run. They may well expect to maintain a strip of coastal waters fairly free from the enemy and available for coast navigation, as do the English at the present time. Thus the size and type of coast-defense submarine of about 500 tons now favored by our Navy Department seems the proper and logical one for American use. American coast defense does not appear to require the largest type of submarines.

There is a great desire on the part of every navy to provide submarines capable of accompanying the fleet and taking part in general actions. For such a purpose a second type of submarine is necessary. In the present state of engineering we shall be obliged to content ourselves with a surface speed approaching the cruising speed of the fleet under war conditions, or about 20 knots. The submerged speed and radius must be very moderate; sufficient only to serve as a means of passive defense by concealment, but not enough for aggressive maneuvering while submerged. High submerged speed and great submerged radius are comparatively secondary affairs unless most radical improvements are brought about in the methods of submerged propulsion, so that high submerged mobility may be obtained without undue sacrifice of surface mobility.

The conclusion to be drawn from this study is that the Navy Department has made a judicious decision in the combination of military characteristics which it has embodied in its latest designs of submarines for service with the fleet as well as for coast defense.

DISCUSSION

Captain W. Hovgaard pointed out that larger boats are more seaworthy and are consequently more habitable for crews on long voyages. He concluded at variance with the author's opinion expressed in the paper that submarines of 800 to 900 tons displacement were needed for defensive and offensive warfare.

Rear Admiral Grant, in a written discussion, believed that the offensive warfare of submarines was the more important, and that the vessels of 500 tons displacement as adopted by the United States were not suited to offensive warfare.

Naval Constructor T. G. Roberts advocated the conclusions of the author, stating that there is but one good reason for 800-ton vessels and that is high surface speed. As a matter of fact a speed of only 17 knots would probably be obtained. He concluded that for coast defense, submarines of 530 tons, such as are now being laid down for the navy, are the best type of boats.

At the beginning of the Friday afternoon session, 23 new members were elected to the Society, and, at a suggestion communicated by Colonel Stevens, it was voted

to authorize the Executive Committee to appoint a committee to draw up a code of professional ethics for naval architects.

Naval Stations and Naval Bases

BY CAPTAIN A. P. NIBLACK, U. S. N.

ABSTRACT

It is important that this country awaken to its strategical requirements in the Atlantic, Pacific and Caribbean, and, as the principles governing the selection and outfitting of naval stations and naval bases are not generally recognized, it is the purpose of this paper, as briefly as possible, to touch on the elements of the problems awaiting us. To outline our peace strategy, let us assume that, among all our navy yards and stations on the Atlantic coast, our two main bases, to be decided upon, are, say, New York and Norfolk. New York, as the assumed center, and Boston and Philadelphia on the periphery of the circle enclosing the main industrial area of the United States, become the true strategical center the instant we deepen the Cape Cod and the Delaware and Raritan canals into ship canals, clear the East River of all obstructions from the Battery to Long Island Sound, and adequately fortify Block Island, Vineyard Sound, Buzzards Bay and Cape Cod Bay regions. With exits at Delaware Bay, Sandy Hook, Block Island, and Massachusetts Bay the entire British Navy, as it exists to-day, could not contain our own navy as it is, although it is continually able to contain a much larger and more powerful one, the German Navy, even with the two exits it has by virtue of the superb Kiel Canal. Our "Heligoland," Block Island, is now only a summer resort, but, defended as it should be, it would be the armed sentinel at the gate. The region around New York, of which we speak, represents billions of dollars, and the expense of providing mobility to our naval forces and security to the area would be but a fraction of one percent. As a mere commercial proposition the enlarged waterway would pay without the guns and mines to secure it, in case of war, and the present serious trend of public opinion makes the whole question one of easy possibilities. The defenses of Cape Cod Bay, Narragansett Bay, New York Bay and Delaware Bay are one and the same question, and the area from Boston to the Delaware Breakwater is our main strategical area.

Our second considerable strategical area is that of Chesapeake Bay, embracing Washington and Norfolk—that is, the national capital and an immensely important naval base. It is far along in our plans to speak of the very desirable proposition of the Delaware and Chesapeake Canal as a ship canal, but it is easy enough to see what it would add to the mobility of our naval forces and to the security of our coasting trade in case of war. Just now the adequate defense of Chesapeake Bay entrance is the main consideration for we have left that "stable door" wide open, as we have also the Delaware Bay entrance. It is therefore idle to talk too much theory when our practice is so elementarily careless.

The first commanding strategical point, in connection with the Panama Canal and its approaches, is Key West. In considering the defense of the approaches to the Isthmian Canal route in the Atlantic and Caribbean, the most striking fact is the commanding position of Great Britain, with Bermuda less than 700 miles from Cape Cod, Sandy Hook and Cape Henry, and with the Bahamas, Jamaica, St. Lucia, Barbadoes and Trinidad commanding the approaches to the canal from all directions. While we all habitually assume the benevolence of British policy toward us, it is not a justifiable strategic assumption. One should not leave his business affairs entirely in the hands of anyone else, if it can be avoided. Fortunately we already possess the necessary positions to secure the approaches to the Caribbean against all comers, and all we need is the sagacity to add to the strategical positions the necessary strength, resources, and mobile defenses to make them good. We have the tactical defenses of the Panama Canal itself well under way and well understood; and we have Guantanamo "on the mainland," dominating Jamaica and the Windward Passage; but we have over and beyond all Culebra Island, the neutralizer of Bermuda and the British West Indies positions—the ideal outlying strategical base—situated 20 miles east of Porto Rico and 20 miles west of the Danish island of St. Thomas. For the price we could possibly purchase the Danish West Indies we could make them useless strategically to anyone else by spending the money on Culebra, only 20 miles distant from St. Thomas.

Almost every drawback that may be glibly cited against Culebra as our great naval base for our fleet in the Atlantic is really an advantage. For instance, it is usually argued that the island and its harbor are too small, whereas, if anything, the island is too large, and the harbor could be even smaller before it would cease to be ideal. Of course it is out of the question to expect to find a ready-made naval base, and we are in luck to have all the treasures we have. There is, above all, no question of Culebra versus Guantanamo, because the latter merely supplements the former. There may be a Culebra without Guantanamo, but no Guantanamo without a Culebra, because Guantanamo is on the undefended mainland, and, with Culebra securely held, it would be on the flank of an attacking expeditionary force operating against Guantanamo.

On the Pacific coast we recognize the importance of two home bases, one on San Francisco Bay and the other on Puget Sound, and so it remains to consider the question of outlying and advance bases in the strategy of the Pacific. Any consideration of the strategy of the Pacific is utterly futile which leaves out the erection of Guam into a great naval base as our key to it for all time—our far-flung outpost of "peace in the Pacific" through armed power in repose. Other positions which we now own, such as Tutuila (Samoa), Dutch Harbor (Unalaska), Sitka, Midway Island, Corregidor, etc., are questions of definite offensive or defensive areas, or of shortening lines of communications, and as such are worthy of consideration as strategic points, but our first necessity is the extension of the defenses of the Panama Canal and Pearl Harbor. Then come Culebra and Guam as great insular bases.

We require naval stations and naval bases to correspond with our policies, with our strategy, and with the requirements of our fleet. It means the expenditure of millions of dollars and is the price of that empire which is ours by destiny, by geography, and by the blood this nation has already shed, but which empire will surely crumble if we sit back.

That preparation in time of peace can only be called adequate which leaves only mobilization as the remaining step in strategy if war unhappily comes. We know what our resources and land and sea forces are, and also those of other nations. We know what our own and other nations' policies are. Our strategy must fit what we have, and if we have little we can do little.

Refrigeration and Refrigerator Insulation on Board Ship

BY ROBERT F. MASSA

ABSTRACT

In insulating refrigerators "built in" on board ship, the best construction, according to the writer, is the use of pure sheet cork cemented with a special cement directly

to the steel surfaces forming the compartment. The second course of cork is set in asphalt after the first course has been carefully pointed up with an asphaltic cement mixed with fine regranulated cork. In this way all possibility of air spaces is eliminated and the chance of any moisture accumulating is avoided. The inside surface may, in this case, be finished in cement, although in some classes of work the cement can be omitted and an asphalt finish used instead.

Difficulty has been encountered with the use of cork that had not been sufficiently pressed previous to baking. This cork was not as dense as it should have been and had not the mechanical strength it should have had. More or less air spaces were left in the cork, into which there was, of course, the tendency for moisture to penetrate, and where the temperature was very low this moisture froze and pried the sheets apart, completely disintegrating the insulation and requiring that the entire work be done over again.

The idea seems to prevail that a refrigerator door should have beveled edges and that these beveled edges make a very tight door. As a matter of fact, such a door can be tight only if it happens to be very carefully fitted. As soon, however, as the moisture begins to have its inevitable effect, the door cannot by any chance be tight. Furthermore, if the hinges yield at all, as they are certain to do with a heavy refrigerator door, it will never be tight, even though it does not warp at all.

In the writer's opinion there is only one practical way to make a tight refrigerator door; that is, to have a plane surface come up against a plane surface with a flexible gasket between these two surfaces. It may also be possible to have a pair of such surfaces, or, rather, two pairs of such surfaces with gaskets between them, making an air pocket between the two seals. If this arrangement is used the door can sag considerably without causing any serious binding or failure in tightness.

In estimating the capacity of a refrigerating machine required for taking care of a given refrigerator, it is not sufficient to calculate the heat loss through the insulation of the refrigerator. This loss in many cases is very much smaller in proportion to the total loss than the average engineer realizes. Heat enters a refrigerated compartment through five avenues: First, through the walls, i. e., through the insulation; second, in warm goods; third, by the interchange of air through the opening of doors and by air leaks through defective insulation or through defective doors, cold air being heavier and immediately flowing out when doors are opened; fourth, from lights or from the heat of the bodies of workers; and fifth, from any change of state occurring in the goods, such as freezing, fermenting, etc. In large rooms these various losses of heat should be analyzed separately. In small refrigerators a rough rule that gives quite as accurate result as a more elaborate analysis allows for a certain number of British thermal units per cubic foot of refrigerator per twenty-four hours. In general, the size of machine for a given refrigerator has to be decided upon before the refrigerator is put into service. On the other hand, where an existing ice-cooled refrigerator is to be cooled mechanically, one check on the size of the machine required is given by the amount of ice which has been used. This check is, however, more likely than any other to lead to wrong conclusions unless the figures are properly analyzed.

The best arrangement of cooling surface in the refrigerator is either to place it in a loft above the box—i. e., above the storage compartment, or in a space alongside of this compartment, with ample air passages to permit the circulation of the air between the two compartments. This arrangement is, of course, inefficient as regards the use of the cooling surface, but gives a very much more satisfactory refrigerator. Moisture is deposited on the coils, the air passes back to the refrigerator partially dried, and, if the box is properly proportioned, the air in passing over surfaces of the refrigerator, as well as over the goods, dries them and keeps them in good shape.

The writer also calls attention to a few of the considerations that seem important in determining the type of machine suitable for any given installation.

The Resistance of Various Types of Barges in Shallow and Deep Water

BY PROFESSOR HERBERT C. SADLER

ABSTRACT

The subject matter of this paper represents a digest of the results of a number of experiments on various types of barges, originally undertaken for the "Board on Experimental Towboats," U. S. Army. A full report in somewhat different form was published as Document No. 857, House of Representatives, Sixty-third Congress, Second Session, but is now out of print. In the original report, the results were worked up for a particular size of vessel (150 feet long). In order to make them more readily applicable to any size, the curves have been replotted in terms of residuary resistance per ton of displacement on a speed-length ratio base (V in knots; L, length over all, in feet; R_w in pounds; displacement in long tons). The wetted surface, and hence frictional resistance, in the different types varies somewhat, but may easily be calculated for any specific size. So far as relative results are concerned, the inclusion of this does not appear to affect the standing of any particular type materially.

In all, nine different forms were tried, the bows and sterns being the same in all cases. They cover variations of "rake" forward and aft, shape of side, and shaped versus flat forms. The middle body in all cases was box-shaped with square corners. The models were all tried at the same two displacements for each type, corresponding to the "load," and "light," or 55 percent of the load displacement. Each model was tested in four different depths of water, or corresponding to a vessel 150 feet in length, these would be 6 feet, 9 feet, 12 feet, and "deep water."

In the shallower water resistance curves tend to arrange themselves into two groups; the forms with the straight sides having, on the whole, greater resistance than those where the sides are curved. The ship-shaped form is uniformly good, but it is followed closely by the scow form. The flat-iron shape with vertical sides appears at its best in very shallow water, otherwise it does not seem to be as good as some of the others. The models with long rake are easily driven forms, but do not have the same amount of displacement at the load draft as the others. The effect of square versus round corners may be seen by comparing these two types. The form with the circular end shows up fairly well in very shallow water, as it is the one of greatest displacement and consequently floats at a lighter draft. In fact, the clearance between the bottom of the vessel and that of the river appears to have a marked effect in the resistance of any form.

In deep water the forms arrange themselves in somewhat the same order, the straight-sided ones having larger resistance than those with curved sides, and those with "easy" rakes less than those with the steeper rakes.

Some additional experiments were made with the same shapes of ends and sides, but with smaller beam. The resistance per ton of displacement for all practical pur-

poses appeared to be constant, or, in other words, the resistance varied about as the beam within the limits of speed for vessels of this type.

All the above forms were tried in groups of six, two abreast and three deep, and certain selected forms in groups two, three, four and five. In all cases the models were lashed close together, corresponding to the common practice in this country. Some of the forms with straight sides show relatively better results when grouped together, due probably to the fact that they present perfectly flat sides and no spaces between, whereas with curved sides offer places for the creation of extra wave-making resistance. In deep water the resistance per ton decreases slightly as the number of barges is increased. In shallow water, by adding one extra barge in front, either in the three or five combination, the resistance is actually decreased as compared with two or four barges. In other words, it is actually more economical to increase the load 50 percent in the case where two barges are towed abreast. The explanation appears to be that the extra barge acts as a "bow" to the others and reduces the wave-making resistance, both by increasing length and reducing head resistance.

In general it may be concluded that, although the ship-shaped form is perhaps the best, taking all things into consideration, a form with a moderate rake and curved sides, is practically as good, and when simplicity of construction and repair are taken into account, the latter form is to be recommended.

Feathering Paddle-Wheels

BY PROFESSOR E. M. BRAGG

ABSTRACT

In the year 1913 tests were made in the model basin of the University of Michigan upon certain models of radial and feathering paddle-wheels. These tests were made for a board of army engineers appointed to investigate the question of towboats and barges for the Mississippi River. The complete report upon the subject can be found in House Document No. 857, entitled "Experimental Towboats."

Since the publication of the above report I have taken the results for feathering wheels and plotted them in a more compact form and have compared the results obtained from the model wheels with those for full-sized wheels.

While it is not the purpose of this paper to discuss radial paddle-wheels, it may not be out of place to call attention to some of the differences which exist between the two types of wheels. The radial paddles give more thrust than the feathering for the same slip, but work at a lower efficiency. The radial wheel has its maximum efficiency at about 10 percent slip, while the maximum efficiency of the feathering wheel occurs at about 15 percent slip. The efficiency for both types decreases with increase of dip but the decrease is less for feathering blades than for radial blades.

The object of the model tests was to determine the best proportions for stern wheels on boats of moderate speed. The dip ratios used were between 1 and 1.5. In applying these results to side-wheels on boats of rather high speed it was necessary to extend the curves to dip ratios of 2.5. This was done on the assumption that the maximum thrust would occur when the wheel was immersed to the center and the thrust would be approximately zero when the wheel was fully immersed. The efficiency curves were extended on the assumption that when the wheel was fully immersed the efficiency would be approximately zero.

The pitch ratio is the ratio of the distance between the trunnions, measured on the arc of the circle, to the width of the blade. Curves showing how thrust and efficiency vary with this factor indicate that as a rule it would be better to sacrifice a little thrust in order to gain in efficiency. If a blade-width ratio of 0.16 is used, a pitch ratio of 1.85 would call for 9 blades, while a pitch ratio of 1.5 would call for 11 blades. At 15 percent slip the unit pressure at pitch ratio 1.85 is 1.6 pounds and the efficiency is 0.668, while at pitch ratio 1.5 the thrust is 1.66 pounds and the efficiency is 0.64. Each of the 9 blades would have to be 4 percent larger than each of the 11 blades, but the efficiency would be a little over 4 percent greater, and the total blade area would be about 86 percent of the 11-blade wheel. Some designers use a large number of blades to reduce vibration.

An attempt has been made to correlate the results obtained from model feathering wheels with the trial trip results of full-sized wheels. It is obvious that the location of the wheel relative to the bow wave is going to influence the working of the wheel to a large degree. In the determination of the wheel location relative to the crest of the bow wave it was assumed that the length of the wave created by the passage of the boat would be $.5573\ V^2$ and that the first crest would be 12 percent of the wave length aft of the bow. V is the velocity of the boat in knots.

The maximum quantities do not occur at the wave crest but a little aft of it. This seems plausible when it is considered that the blades enter the water some distance forward of the center of the wheel and it is the first part of the stroke which is most effective. Also the wheels have considerable length, and the wave crests are not parallel to the axis of the wheel but rake aft. Another possibility is that the wave crest is more than 12 percent aft of the bow.

The model wheels, when tested in the tank, were not adjacent to the hull of a boat, and by reason of this condition the dip observed when at rest would be very close to the dip when in motion. The apparent slip and true slip of the model wheel would be practically the same. The only condition tending to affect these would be the velocity of approach of the water to the wheel, which would be very small.

The paddle-wheel of a side-wheel boat is working under quite different conditions as regards dip and slip. The velocity of approach would be somewhat larger, due to the proximity of the hull. Due to the passage of the boat through the water there will be stream-line flow, wake and waves.

The dip of the blades when the boat is in motion may differ considerably from the dip when at rest, depending upon the part of the wave in which the wheel is working. The true slip of the wheel will differ from the apparent slip because of the velocity of approach, wake, stream-line flow and orbital motion of the water in wave formation. If the wheel is working in the hollow of the wave, all of these except the wake make the true slip less than the apparent slip. If the wheel is working in the crest of the wave the wake and orbital motion are opposed to the stream line flow and velocity of approach, and the true slip is probably greater than the apparent slip. It would appear, however, that the change in slip is much less in degree than the change in dip.

In addition to this uncertainty regarding the true slip and true dip of the full-sized wheels, there is further uncertainty regarding the variation of thrust with speed of advance. The usual assumption is that the thrust varies as the square of the speed of advance. The models were all tested at a speed of advance of 100 feet per minute while the full-sized wheels were moving at a velocity of about 2,000 feet per minute. The model

wheels were practically 1 foot in diameter, while the full-sized wheels were from 25 feet to 30 feet in diameter. According to the law of comparison the corresponding speed for the full-sized wheels would be about $100\sqrt{30}$, or about 550 feet per minute. The full-sized wheels were advancing at speeds which were three to four times the corresponding speed.

With these three unknown conditions—namely, the variation of thrust with speed of advance, the variation of true dip from the observed dip at rest, and the variation of true slip from the apparent slip—it can be readily seen that there are a large number of relation factors which might be derived, depending upon the assumptions made regarding one or all of the unknowns. In the paper are given only two relation factors, one which is called the virtual slip and one the virtual dip.

Alquist Gearing for Ship Propulsion

BY W. L. R. EMMET

This paper is published on page 536.

Electric Pumping Equipment and Notes of Interest on Union Oil Company of California's Tank Steamer La Brea

BY HUGO P. FREAR

This paper will be published in the January issue.

The Commercial Gyroscopic Compass

BY ELMER A. SPERRY

Abstract

With the advent of the gyro-compass for navigational purposes, there was introduced for the first time an instrument of precision whereby courses could be laid with great accuracy, and dead reckoning computed with an exactitude theretofore impossible. The compass incorporates as an essential feature an indicator of its true meridional bearing. With the gyro-compass there is never any necessity for swinging the ship. Within the last four years a large mass of data has been accumulated of the performance of the gyro-compasses upon practically all of the "seven seas." These records agree in demonstrating that in the gyro-compass we have an instrument entirely free from all of the difficulties and disturbances to which the magnetic compass is subject.

The field of force utilized and upon which the new navigational instrument depends for its directive power is the actual rotation of the earth. This angular motion, although it occurs about an axis some four thousand miles distant, through a well-known gyroscopic phenomenon, compels the gyro wheel to set its spinning axis parallel with the axis of the earth. The earth's rotational force is so impressed upon the gyro as to cause this phenomenon to take place with the greatest exactness, so that it may be employed as a navigational compass of high precision. The phenomenon being a terrestrial one, the pointing is upon the true geographic meridian, which is identical with that utilized in navigation; therefore, when the compass is properly organized, no deviations or variations exist to complicate its use.

The reason for the high precision of the gyro-compass lies in the fact that, in addition to its true meridional pointing, its tenacity of purpose or directive power is many times that of the magnetic compass. The directive power of the new commercial compass is about one hundred and fifty times that of the same standard navy magnetic compass, in the positions occupied in both naval ships and those of the merchant marine.

In the gyro-compass equipments using repeaters, a secondary transmission system is employed. This comprises a transmitter, operated by and forming part of the master compass, and various forms of repeating instruments, controlled by the transmitter, but located at distant points about the ship. The transmitter is power driven by the compass and is also connected with the automatic correction device in such a manner that only corrected readings of the master compass are transmitted to the repeaters, which thus read in true bearing on the meridian. Repeaters, which indicate the true headings of the master compass, may be located wherever desired on the ship. Various other devices, such as azimuth indicators, recorders, automatic latitude instruments, ordnance appliances, automatic steering mechanism, etc., may be operated from the same circuits that supply the repeaters.

All repeating instruments are positively driven by especially designed step by step motors, which have no moving contacts in circuit. These instruments follow the movements of the master compass with a maximum error of about 1/12 degree and a lag of about 1/100 of a second. Less than ten watts of energy are consumed for each instrument, yet the card is driven with as high a torque as 10,000 gm. cms., which abundantly insures the instruments against derangement from shock of gunfire.

Not only is there an entire absence of variation and deviation in the Sperry gyro-compass, but extended experience at sea shows that there is no heeling error even in the heaviest rolling, this being true for all headings.

The new compass for merchant ships is smaller and lighter than the battle gyro-compass, and is being developed in a still smaller form for use on aeroplanes and small yachts. As built at present, it weighs only about fifty pounds, exclusive of the binnacle in which it is mounted, the complete weight with the binnacle being only about 225 pounds. The smaller size will weigh only about 40 pounds when the aeroplane mounting is used, there being no binnacle. The overall diameter of the compass with the binnacle is only about 16 inches, and the weight about 100 pounds. Due to the small size of the wheels (the wheels used on the destroyer type are only five inches in diameter), the time required to bring the compass up to speed from rest is only about five minutes.

Three standard compass equipments are supplied. The simpler equipment consists only of the master compass, motor generator, and a very simple switch panel, while the larger equipment contains in addition a pelorus stand, storage battery, two repeater compasses, and a larger switchboard, one panel of which is to care for the repeater compasses. These equipments are being installed on the secondary naval ships and the larger ships of the merchant marine.

Another equipment is also provided in which the pelorus stand is omitted and a switchboard intermediate between the two illustrated is supplied. The entire master compass operates on alternating current, and in the case of the equipment where no repeater compasses are used, the motor generator simply converts a slight amount of the ship's supply of direct current into alternating current of the proper voltage and frequency. The generator operates automatically. The repeater compasses, however, operate on a low voltage direct current, and the motor generators for these equipments are extended on one end and serve also to generate the slight amount of low voltage direct current required. In these equipments a storage battery is also provided, and arrangements are made so that, in case of failure of the ship's supply, the entire compass equipment will be automatically transferred to the storage battery, which has sufficient capacity to carry the entire equipment independently for a period of two or three hours.

Not only can the gyro-compass actuate the automatic helmsman, which holds the ship with great precision and minimum help, but it may also operate a recorder, which makes an automatic record of every change of heading, however minute, recording the exact moment of such change; thus giving a continuous and accurate record of the heading of the ship. This instrument is incidentally useful in obtaining the characteristics of different helmsmen, and its records are of the greatest value to the navigator, especially when observations are impossible—navigating by dead reckoning.

NAVAL ARCHITECTS' BANQUET

The annual meeting of the Naval Architects' Society was brought to a close with a banquet at the Waldorf-Astoria on Friday evening, November 17. Stevenson Taylor, president of the society, presided. The speakers included Rear Admiral Nathaniel R. Usher, U. S. N., who spoke on preparedness; Bernard N. Baker, who discussed the shipping board in its relation to the American merchant marine; Charles Sherrill, who discussed the modern Monroe Doctrine; A. L. Thurman, who spoke on the marine work of the Department of Commerce, and G. E. O'Dell, whose subject was "Is the Doctrine of Equality Played Out?"

NEW BOOKS FOR MARINE ENGINEERS

THE MECHANICAL HANDLING AND STORING OF MATERIALS. By George Frederick Zimmer, A. M. Inst. C. C. Size, 7¼ by 10 inches. Pages, 752. Illustrations over 1,000. New York, 1916: D. Van Nostrand Company. Price, $12.50 net.

REVIEWED BY H. MCL. HARDING *

The subject of mechanical handling and storage of material is one which now appeals most strongly not only to all manufacturing industries, but to transportation interests and to every engineer, whether civil, mechanical, electrical and especially to all terminal engineers. While there are a few treatises on this subject, yet one that is authoritative and embraces the latest developmens and improvements is the only one of practical usable value. Otherwise a supplanted machine or an ancient method might be accepted as being the best.

The contents of this book will be found satisfactory to all who have had occasion to consult such a work for complete and precise information. Improvements in mechanism and methods are being made daily and the last machine is often the one which, if adequately described, would be adopted.

As to the different types of conveyors, the tables, giving data as to sizes of the parts of the various conveyors with the speed, tonnage and bushel capacity per hour, will be of great value to all mechanical engineers. The diagrams are exceedingly clear and give that information which is always wanted and is so often omitted. Full appreciation by the author of the value of a properly annotated index is immediately evident.

TRADE AS A SCIENCE. By Ernest J. P. Benn. Size, 7½ by 5 inches. Pages, 184. London, 1916: Jarrold & Sons.

Although this book is published to stimulate the enthusiasm of the British public in the subject of trade and to bring about more scientific methods in the handling of trade, it will be exceedingly interesting to American readers, for the subject of trade is discussed in a very earnest and comprehensive manner. In many respects it is brutally frank in the way it exposes British weaknesses in trade and business in general, and such frankness cannot fail to be helpful in bringing about a more systematic method of carrying on British trade after the war. The book contains much that will be of interest to Americans; for, although Americans may have some advantages over other countries, they are undoubtedly weak in many respects, and should not hesitate to learn where trade plans can be strengthened.

It will surprise many Americans to learn from this book the lack of co-operation among British business men. That the average Britisher is an excellent business man cannot be questioned, and anyone who has had experience with him cannot fail to admire his splendid integrity, which is probably not equaled by any other nation. His great weakness seems to be that he does not want to co-operate with others, particularly in his special line of business. Instead of being proud of his business and saturated with ambition to build it up and strengthen it, making a record each year over the previous year in efficiency and success, he is more given to keep under cover the fact that he is in business.

If British people benefit even partially by what is said in this book, we may look for a greatly strengthened foreign trade in Great Britain as soon as the war is over.

* Consulting Engineer, New York.

THERE AIN'T NO NEWS

A Story of the Water Front

BY FRANCIS KEY

"Cap, what's the news of the Nancy Ann?
Tell me the news, mister, if you can."

"We are just in from around Biscay,
But there ain't no news for you to-day.
Our ship was blowed on the rocks by squalls,
And the crew was et by cannibals.
But there ain't no news."

"Oh, mister, can your ship go some?
Was she built to go, or built to come?"

"This ship, me lad, is so full of speed
That she goes so fast the crew can't feed.
When we left Biscay the other day
We went so fast that we boiled the bay.
But there ain't no news."

"Oh, mister, have you seen any storms,
Any U-boats, serpents or fearsome forms?"

"No U-boat, lad, have we seen, by heck!
Or else we'd beat 'em across by a neck.
A lad's aboard with a wild harpoon,
And playin' U-boats is his favorite tune.
But there ain't no news."

"Oh, Cap, is your wife aboard the ship?
Did you bring your children on this trip?"

"My wife's at home—where she ought to be—
For women, y' know, don't like the sea.
Besides, me lad, 'tis a pleasure trip,
And I've a flask in my starboard hip.
But there ain't no news."

—From the New York Herald.

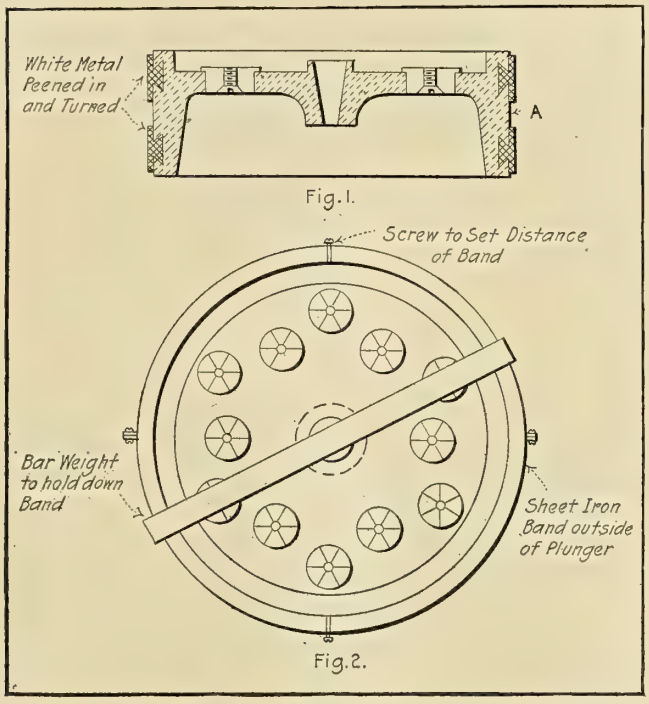
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Economical Repair to Worn Plunger in Main Air Pump

When the plungers of air pumps and the cylinders become worn and out of round, there is caused a loss of vacuum. Recently, after great efforts in locating and stopping small leaks of air into the system, with very little effect on our poor vacuum (24 inches), we decided to examine the bores of the air cylinders and the fit of


White Metal Peened in and Turned
A
Fig. 1.
Screw to Set Distance of Band
Bar Weight to hold down Band
Sheet Iron Band outside of Plunger
Fig. 2.

Section of Worn Plunger, Showing Method of Repair

the plungers. It resulted in finding that they were considerably out of true in their circumferences. Very nearly 3/64 inch opening all around the plunger was shown by the use of feelers, and when the cylinder walls were calipered they were found to be 1/16 inch out of true at the largest diameter. The plungers averaged the same.

These conditions really called for either renewal of the liner of the cylinders and truing up the plungers, or reboring and new or built-up plungers. Either of these repairs would have been expensive for this vessel when it is considered that she is fifteen years old and her machinery in very poor condition. Therefore a repair was made as shown in the accompanying sketches.

The plungers were placed in a lathe and trued up. This reduced their diameter, and dovetail grooves were turned in the face as shown. A sheet iron band one inch larger in diameter than the plunger was made in two pieces and bolted together with a gasket between the joints. A piece of flat boiler plate was found large enough on which to set the plunger. A bed of fire clay was mixed up and spread around this plate in a circle wide enough on which to bed the plunger and the sheet iron band, as shown in Fig. 3. Four regulating screws were put in around the circumference of the band at the center of its height to equalize the space between it and the plunger. The plunger and band were placed on this bed of fire clay and the clay tamped up tight on the inside of the plunger with a small rod worked through the valve seat holes, and at the bottom of the space between the band it was tamped down hard, crowding it under the edge of the plunger. The plunger itself, being heavy, made this a good joint. A heavy bar was laid across the top of the band to keep it down hard in the clay. This completed the mold.

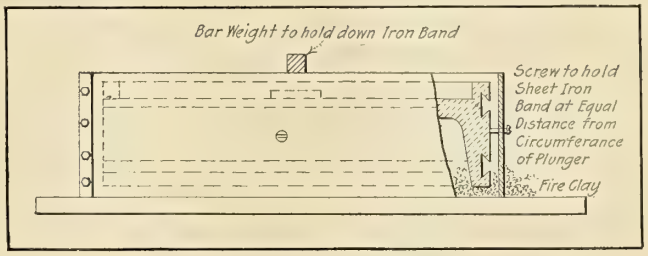

Bar Weight to hold down Iron Band
Screw to hold Sheet Iron Band at Equal Distance from Circumferance of Plunger
Fire Clay

Fig. 3.—Mold for Pouring White Metal

White metal was melted and poured into it, pouring from two big ladles the metal melted in a crucible on a hand forge. When cold, the band was removed and the white metal then peened in with a ball peen hammer.

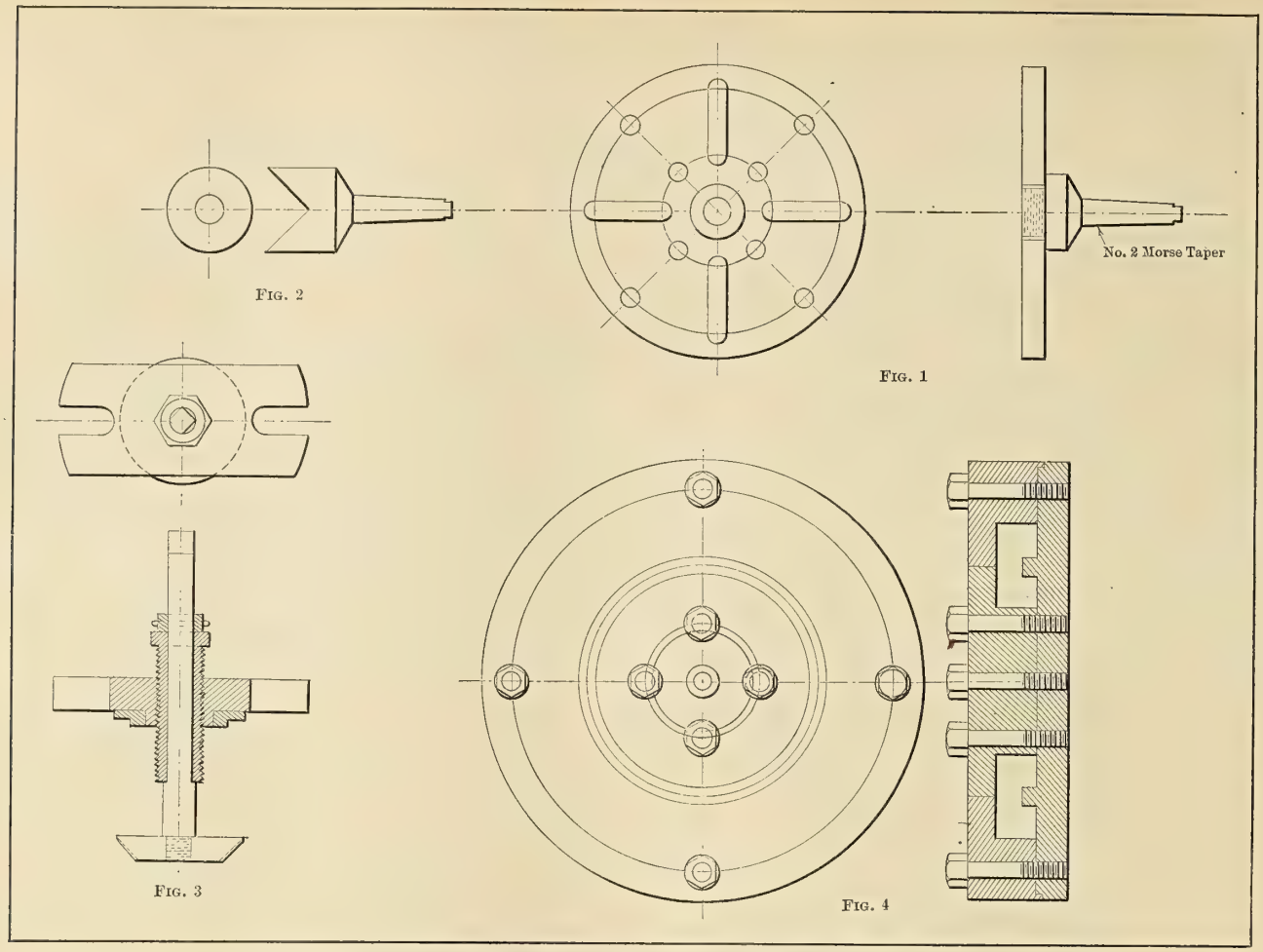
The plunger was then placed in the lathe and machined as shown in Fig. 1 to a little larger than the large diameter of the cylinder—about .015 thousandths. It was then scraped and rasped off with a course rasp until it fit the bore of the cylinder in the position in which it was to operate, it being secured against turning by pins in the piston rod at the crosshead and at the shoulder on the plunger where the rod fits the taper. The space between the two rings of babbit or white metal at *A* in Fig. 1 formed a water seal at each stroke.

The result at the completion of the test was very pleasing, for we obtained 28.5 inches of vacuum. The pumps have been operated through some 16,000 miles of steaming and still hold up 28 inches with a fairly moderate speed of operation. The work was all accomplished on board ship and the time required was five days to do two plungers of a twin air pump. C. H. W.

Some Economy Kinks

On taking charge of a bay steamer some time ago I found rather a poor tool equipment. We were soon provided with ratchets and drills and bolt and pipe threading tools, hammer, chisels, files, etc., so we were not quite dependent on the shop, but I think every boat that has room for its installation should have a lathe. As we had plenty of room in the shaft alley and a 1-horsepower motor in the kitchen that had been installed for a dish washer, but was not used for that or any other purpose I suggested that we install a lathe.

The suggestion was adopted and we got a light 13-inch



Economical Repair Jobs—Turned Out on Board Ship

lathe and an 8-inch emery wheel which, with a countershaft and the motor mentioned above, gave us a fair shop outfit. The convenience of the thing and the economies we have been able to effect have been surprising. The whole outfit entailed an outlay of less than $200 (£41.1), and it had more than paid for itself in the first year it was used. By means of this shop outfit we are able to keep up the auxiliary repairs at practically no outside shop expense. We make our own piston and valve rod packing for the main engine, turn up our valve disks and stems and reseat the valves, make our small rods and bushings, pump valve guards, glands, rings, etc.

On of our first jobs was to make the plate fitted to the taper shank shown in Fig. 1. This we use in the tail stock when drilling flate or irregular parts. When drilling round parts we use the V block (see Fig. 2), which was the result of our next effort along this line. Later we made the reseating machine, Fig. 3, which answers our purpose quite as well as the more expensive patent machines.

We designed and made this complete, except cutting the teeth in the cutters, which we had done on a milling machine. We made bushings and cutters, adopting the machine to the different sizes of valves for which we use it, which are mainly the boiler feed stop, check and blow-off valves. Note that the feed screw has a left-hand thread. If the screw should stick and turn with the spindle it will feed away from the valve seat, thus not digging into and spoiling it.

On the main engine we use metallic packing. The white metal rings are cut in two, three or four pieces, and are held against the rod by a spiral spring, which is carried in a groove on the back of the ring. The rings are carried in a series of cast iron cups, each cup carrying two rings, four cups making a set for a rod. When we came to renew the rings we found it a rather expensive proposition, so we decided to try our hand at making them.

We made a cast iron mold in which to run the white metal casting, which we made 6 inches long, allowing material inside and out for boring and turning. We then rough turn and bore and cut off the rings, cutting the groove in the outside to provide means for clamping them to the face plate. We then clamp them to the face plate and finish both sides, bringing them to the exact thickness required (micrometric measurement). We then cut them with a cold metal saw, the saw running on a mandrel between the lathe centers and the ring, being held between clamps on the tool post and fed into saw with the cross feed; all of this equipment is "home made" except the saw. The rings are then clamped in the jig, Fig. 4, and finished to the exact required diameter, the center cap being removed for boring, after which the center cap is replaced and the outer one removed for finishing the outside. The result is a ring fitting the rod perfectly and the ends fitting together nicely at the joints.

Neither the number of pieces in which the rings are cut, nor the exact angle at which the cut is made, seems to affect the results very much. We have tried cutting them in two, three and four pieces and got good results with all of it, finally adapting the three-piece ring.

Something else that gives us very little trouble is the alloy of which they are made. We began using 83 1/3 lead, 8 1/3 tin and 8 1/3 antimony. This gave a rather soft metal, though we got very good service with it. Later we increased the percentage of antimony. As we use the

old metal over, it would be difficult to say just what we are using at present. A superintending engineer told me some time ago that his people were using their old bearing metal for rod packing, so I have decided that the exact composition of packing metal is not by any means a vital point, the metallic packing salesmen to the contrary notwithstanding.

For small rods and stems and check and stop valve stems we have got very good results by mixing bird shot, assorted sizes, fours to nines, with pulverized graphite and pulverized mica, with just enough oil to hold it in a mass. It works best when stuffed into strings like frankfurters, though we frequently use it without that preparation. We have used nothing else on our boiler stops and checks for about two years, and it is the only packing we have ever used on our dynamo engines that would hold and not wear the rods rapidly.

D. SAWYER,
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Norfolk & Washington Steamboat Company,
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Stops Valves

Many have been the accidents due to steam valves and the omission of any indication as to their open or shut condition. Many lamentable happenings have been averted only by narrow margins due more to good luck than sound judgement. So long as valves are fitted giving no reliable and positive indication of their adjustment, so long will the opportunity exist for causing danger to life and personal risk by wrong manipulation of the hand wheel in perfect good faith. Two instances in the writer's experience point their own moral, and if damage did not result it was not from lack of opportunity.

The main stop valves in a certain steamer had been overhauled in port, valves examined, ground in and glands repacked. The engineer responsible omitted to see that they were definitely closed, or else opened them full in mistake. Fires were subsequently lighted and steam raised slowly during the whole night. No one troubled about the job until it was decided to warm up the engines a few hours before the tide served. To the amazement of the engineer on anchor watch, the engines were found warmed up with full steam on. No water having been circulated through the condenser, which was found red hot, hasty test failed to locate a leak, but the consequences of the open valves could have easily been serious enough and might have involved a cracked condenser and considerable delay to sailing.

To this day the writer marvels that no one noticed the condition of the engines, but as they had had a lengthy overhaul, the rod glands were tight, having been repacked so that no drips gave warning. The job was small and no one was at work in the engine room, all overhauling having been completed. Had the crank not been on top center, a movement might have given an indication, or, for that matter, might have resulted in casualty. Such a method of warning, though, is not unknown, but it is done with full knowledge. In the instance cited it was a matter of accident, not design, which might have resulted in serious damage.

Now, although the oversight may be rightly attributed to the engineer on anchor watch, a greater responsibility rests on the design of the valve, which was unprovided with any indication of its condition.

The second instance concerns tank valves. These as fitted were of the center-guide type, with very limited thread length. In the replacement of one of these after overhaul the cover was replaced with the spindle in open condition. The valve guide spindle failed to get into the proper opening, and, screwing the valve down, bent the pin integral with valve. As usual, the distribution box was in a dark corner of the stokehold and the engineer making the overhaul guessed by the feel of the wheel spanner that it was down. The sea suction was also improperly closed or left off its face, and in a twelve-hour passage the steamer was 2 feet or more down by the head owing to filling of No. 2 tank. The consequences, as only part of cargo was loaded, were not serious, being confined to pumping out. With a fully laden vessel and heavy weather, the result would have been to make her less seaworthy and might conceivably have led to disaster.

How many sea injection valves for circulating water have been found with stripped threads at awkward moments it would be idle to conjecture, but the number must be considerable. To dismantle such a valve outside a dry dock afloat in port is an operation not free from danger. The usual rig with double tarpaulins under ship's bottom is a risky proceeding which might result in sinking the ship.

Now, the blame for all such instances of default lies at the door of the shipbuilder and engine designer. Valves with concealed spindle threads should never, in any instance and under any consideration of cost or builder's convenience, be fitted. If the spindle thread is external, its condition and the movement of valve can be seen. There is no difficulty in the provision of such valves. Also reliable external indication of an arrow on the hand wheel and, more essentially, an external indication of the actual position of valve relative to seat should be provided. It should be possible in the dark to know by feel only exactly the position of the valve, while full open and shut positions should be so visible externally that they can be seen whenever the eye chances to fall upon them. It also costs little to place a brass plate on every valve in a ship clearing stating what it is, so that no mental work or time to trace pipe lines is needed before its use is apparent.

A distribution box is essentially a more mechanical device than a three or four way cock. The latter is certain to leak after the passing of time, and to grind in the plug of an 8-inch diameter cock costs more in time and labor than can be spared in a steamer's engine room. If the designer had to do the grinding in there would be less cocks fitted of any relative size.

If Mr. Designer will give us valves with external threads, have reliable indicators fitted, fit fewer cocks and himself see that engraved brass plates are affixed to each valve, we shall all be duly grateful. If, in addition, he will draw a large size piping diagram on the lines of an electrical plant wiring diagram and insert same permanently in a panel of the mess room with thick plate glass in front, he will be of service. If, in addition, he will so group the valves which are themselves controlling gear in positions which instinctively label themselves in place of saving a few feet of piping to assort the valves in unrelated position, his memory will be blessed.

Too little regard is paid to the question of convenience of the operation, too much to a cent-wise and dollar-foolish outlook in the matter of pipe. The question of piping and the control points—e. g., the valves—is work worthy of brains and intelligence. Some steamers' arrangements make one think this had been an oversight hastily remedied at the last moment by an incompetent junior. There is nothing more galling to the engineer afloat than the haphazard arrangements met with which could have been rectified at no increased cost when the job was in the paper stage.

A. L. HAAS.

London.

Setting and Care of Spring Loaded Safety Valves

The first law about safety valves should be that no one who does not thoroughly understand them be allowed to try setting or making any repairs to them. They are the guardian of many lives and the protector of considerable property. The inexperienced can best learn by assisting a few times some capable man to make repairs and adjustments and by procuring printed matter from the makers of the type of safety he desires to learn about.

Perhaps the most common trouble with safety valves is sticking, when either open or closed. This in almost all cases is due to lack of care. When a safety lifts by steam, if there is any scum or sediment in the water or dry pipe, there will be some of it left in the safety valve. It dries on and starts trouble unless the safety valves are lifted each day with the hand-lifting devices. When a safety sticks open, most people send a man up to tap the stem to seat it, and if it is stubborn he hits it a little harder and maybe bends the stem or upsets it. This is bad practice and it can be avoided by use of the hand-lifting device and a cleaning of valves when the boiler is under repair or cleaning. The safety valves can be removed without disturbing the setting in most types, their parts cleaned, lubricated and replaced.

The prevention of rusting and corroding of the springs is very important. The springs should be nickled, as this protects them, and each plant should have at least 10 percent of the total number of springs spare. The springs of most types of safety valves are enclosed in an atmosphere cylinder. This is intended to eliminate the escaping steam pressure, acting on top of the valve, and not as a protective compartment for the spring. Some steam vapor or moisture from the air will always find its way in to attack the springs. This compartment does, of course, reduce the chances of corrosion, in keeping the escaping wet steam from direct contact with the spring.

To maintain the working parts of a safety valve in good order I recommend the use of a good grade of graphite lubricant. The use of oil is of little value, as the heat over the boilers soon dries it, and if it is a poor grade will leave the parts gummed up. This applies especially to the parts of the hand-raising devices.

The setting or adjusting of the valves to rise at the same working pressure and reseat with a small loss is accomplished by compressing the springs with the nut sleeves and adjusting the blow back ring or lip, bearing in mind that decreasing the space between the ring and seat makes the valve rise for a longer period, and increasing the space allows it to blow for a shorter period. Five pounds is the proper amount to allow it to blow back. If the ring is moved too far away, it will allow the valve to lift and chatter until such time as the pressure falls below the setting, which it does only when you have your steam controlled. Chattering injures the valve seats and should not be allowed. The blow back rings are secured by a plug screw or other means and it should be done carefully to prevent their changing.

When setting the valves of a safety composed of two or more valves in one body the others must be gagged down. Only one valve of a set can be properly set at a time. I have known engineers that in place of gagging down the other valves would screw down hard on their adjusting nuts. This is very poor practice and I think injures the spring tension.

Always, when setting the safety valve of a boiler that is connected to a battery of boilers, use a test gage, or master gage, and do not go by the one on the boiler. It may be all right, but the test gage is the best method and insures the proper setting of all valves. The plan used for settings in this plant is that the boilers furtherest away from the main engines are set to blow 5 pounds lighter than the ones nearest to them.

When you are raising steam in a boiler, to set its safety remember to have sufficient water in it to do the work safely, for if the other boilers are carrying lower steam pressure, as, for instance, say 125 pounds, and the one you are setting has to be raised to 225 pounds, you will not be able to feed it against this pressure and you have the trouble of cutting it into the steam line in order to lower the pressure to feed it. This wastes time, and setting safety valves is a hot, uncomfortable job, so it is well to make a few preparations ahead of time.

When connecting up the hand-lifting devices after setting the valves examine them to see that all valves lift together, if there are more than one. This is accomplished by proper fitting of the keys through the stems and adjustment of any lost motion in the levers.

C. H. W.

A Poor Combination

A month ago I boarded a steamboat for a little vacation trip, and, of course, wanted to know what kind of machinery they had on the boat and how it worked.

I was directed to the chief engineer first, met him, asked if I could "look around," and was obligingly told that I could. In fact, he went so far as to instruct his assistant to show me whatever I wanted to see.

It was evident at a glance that the chief was a busy man indeed. He was poring over some blue-prints all the time that he spoke to me, and so, not wishing to be a disturber, I went my way with the assistant.

Now, the assistant was a good enough kind of a fellow, but I immediately learned that he leaned too heavily on the chief. He couldn't answer many of my simplest questions. He knew the speed of the boat, the turns per minute of the propeller, construction of parts and other things that even the oilers might know, but he knew nothing definite about the efficiency of the engines. He had helped to take cards and set valves, but he didn't know the results. "The chief knows," he would state, as though he expected me to ask the chief, and as though such ignorance was excusable.

He didn't know why the vessel as equipped with engines rather than with steam turbines. He knew how the refrigerating system worked, but didn't know if it was a compression or absorption system.

He didn't know the exact total power of the engine, but "the chief knows," he said.

The engines were very noisy—so noisy that I had to shout into his ear from a distance of about one inch. "Where is the knock?" I shouted when we were close to a particularly noisy spot. He pointed into a mass of moving cranks and rods and shouted back: "In there; low pressure valve; the chief knows!"

So I concluded that there was something wrong somewhere in the management of the engineering department. Either the chief wanted to keep his assistant in ignorance, as is often the case, or the assistant was following the wrong vocation. On the surface it looked as though the chief did all of the heavy thinking. The assistant didn't seem to care. He could have easily known most of the things he didn't know, in spite of the chief.

I have been on several steamboats in my lifetime, but I never before heard such noisy engines anywhere. It is therefore my own personal opinion that they should have a new chief and a new assistant on that boat.

New York. N. G. NEAR.

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, and defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Rake of Masts

Q.—What is the customary rake to masts and stacks of steam vessels 300-500 feet in length? S. B.

A.—It varies somewhat with the characteristics of the vessel and the preference of the designer. A common rule is to slightly increase rake of each member as you work aft, starting with about ¾ inch per foot for the foremast, 1 inch per foot for the stacks, and 1¾ inch per foot for the mainmast.

Aeroplane Propellers

Q.—Why are aeroplane propellers always two-bladed? A. E.

A.—They are not. Three-bladed propellers are common, and some of the new European war machines have four-bladed propellers. In general, two-bladed propellers are more efficient, and are used. If in design the horsepower of the engine requires an abnormally large diameter for a two-bladed propeller the designer reverts to increasing the number of blades, thereby decreasing the diameter.

Heat and Mechanical Energy

Q.—Please advise through your columns whether the heat generated by compressing air is due to friction or to the concentration of the heat contained in the larger volume into the smaller volume? V.

A.—To neither; but to the *work* expended in compressing it, which is transformed into heat. Heat is not matter, but, according to accepted conceptions, a form of energy. The old "caloric" theory considered heat as an all-pervading *fluid* which actually flowed from the hotter to the colder body when the two were placed together, but this was definitely disproved by Rumford, Davy and Joule, the latter establishing the quantitative evaluation between work and heat. The present conception of heat is that it is a name given to an active agent to account for changes in temperature; that it is not a substance, but a form of energy, and that this energy is due to the motion or relative positions of the molecules of a body or system. Heat may be generated by the expenditure of mechanical energy, and, conversely, work may be produced by the expenditure of heat.

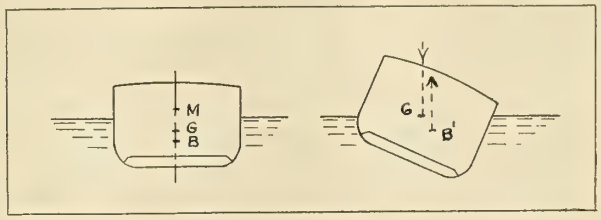
The instance you cite belongs to the former category, while in the latter is the steam engine, hot-air engine, etc.

If you strike an anvil a blow with a heavy sledge its face becomes heated, and simply because you have converted the kinetic energy (which is by definition "the ability to do work") $\frac{M v^2}{2 g}$, into heat; in the same way when you do work in compressing air the equivalent of the work done is given to the air in the form of heat with attendant rise of temperature. The quantitative evaluation of this energy transformation is given by the mechanical equivalent of heat, or 1 B.t.u. = 778 foot pounds of work, which may be stated that 1 B.t.u. requires for its production, and can produce by its disappearance, 778 foot pounds of work.

Metacentric Height

Q.—In a ship the center of buoyancy usually lies below the center of gravity. Can you explain to me why it is that still the ship has stable equilibrium? If the buoyancy acts at B and the weight acts at G, I should think there would be unstable equilibrium, like a balanced stick. E. B.

A.—As soon as a ship is heeled, the center of buoyancy moves over, as it is the center of figure of the immersed careen, and the buoyancy acts through this new position of the center of buoyancy, B^1. Taking the product of the displacement and the horizontal distance between the $C.\ G.$



Position of Center of Buoyancy

and the new position of the $C.\ B.$ gives the righting moment. The smaller the angle of heel the smaller the righting arm and the more nearly the vertical through the new $C.\ B.$ cuts the original vertical in the position B. If at the limit it actually came down to B your conception would be correct, but it can be shown that it never gets to B, but is above it even at zero inclination. This point, the intersection of the vertical through the new $C.\ B.$ with the original vertical is called the metacenter (M), and is where the buoyancy should be considered as acting for all computations.

Labor Costs

Q.—I wish to secure the following information pertaining to contract labor in shipyards: Tables showing the price of removing cast iron or steel in lathes or planers per cubic inch or per surface inch in different thicknesses, rough machined and finished. The cost of punching holes in steel plates and angles and driving rivets per hundred of different dimensions; also fitting plates per hundredweight.

There are tables of this kind in use in Europe, to the great benefit of the manufacturers and shipyards, as well as to the benefit of the employees. Of course these tables are used as a base only and the prices vary in different localities. K.

A.—Rates of prices for piece workers in the shipbuilding trade are published in Great Britain in booklet form by the various trade unions, and are issued to their members as confidential information. These itemize work and prices in great detail and serve as a basis of estimation and payment for all contract work between the piece worker and the shipbuilding company. There are no similar data issued in this country, and the foreign sheets are of very little value here, even as a base, because the method of contracting and rates of pay differ so greatly.

The most concrete information as to prices actually paid

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

Cost of Riveting (Machine Work).
RIVETING MACHINE.
PART I

CLASS No.	Class of Work determined by conditions: (a) Accessibility for riveting. (b) Complexity and difficulty determine skill required. (c) Continuity or contiguity of rivets.	Price Per 100, dollars and cents. Diameter of Rivet.						
		⅜	½	⅝	¾	⅞	1	1⅛
	S—Size Number.	3	4	5	6	7	8	9
0	On Ground-Riveting with Bull Machine	....	1.00	1.25	1.50	1.75	....	7.50
1	On Ground-Easy structural work with air hammer	1.00	1.25	1.50	1.75	2.00	....	....
2	On Ground-Bulkheads, Decks, Floors	1.25	1.50	1.75	2.00	2.25	....	....
3	On Ship-Beam brackets and gussets, Bulkheads, Deck, Deck houses, Floors, Longitudinals	1.50	1.75	2.00	2.25	2.50	2.90	....
4	Keel-Keelson, Inner bottom, Shell-Hatches and Coamings, Bounding-bars, Stringers, Turrets	1.75	2.00	2.25	2.50	2.80	3.20	....
5	Boat cranes, Chutes, Trunks, Doors, Manhole Covers, Guards, Masts, Bulkhead Staples, Clips	2.00	2.25	2.50	2.75	3.10	3.60	....
6	Ammunition hoists, Bilge Keels, Cofferdam, Chain Lockers, Peak Tanks	2.25	2.50	2.75	3.00	3.50	4.10	....
7	Boiler Saddles, Engine Foundations	....	2.75	3.00	3.40	3.90	4.60	....
8	Stanchions, Miscellaneous Foundations, Struts, Rudders	....	3.00	3.30	3.80	4.40	5.20	....
9	Stem, Sternpost	....	3.25	3.70	4.30	5.00	6.00	7.50

CLASSES 3 and 4 are Flush riveting prices, in new work. Deduct 0.25 per 100 for snap riveting prices in new work.

in an American yard is given in "Estimating the Cost of Work," by W. B. Ferguson, which gives actual costs of work.

From this the cost of punching material delivered to the machine is:

	Per 100 Holes
(1) Small plates or shapes handled by two men	$0.10
(2) Large plates or shapes handled by two men, ½ inch and under	0.20
(3) Large plates or shapes handled by four men, over ½ inch	0.25

Effect on Ship of Unbalanced Forces in Twin Screw Engines

Q.—A vessel is provided wtth two sets of engines driving twin screws which are at a distance of 14 feet apart. Each crank shaft has two cranks at right angles to each other. The weight of the reciprocating parts of each engine is 3 tons; the stroke, 39 inches; the revolutions, 140 per minute. Determine the greatest force tending to uplift or depress the vessel; also the greatest heeling moment. VANDUARA.

A.—The greatest vertical free-force occurs when a crank is at the top or bottom of its stroke, then the accelerating force along the line of dead points is a maximum.

The accelerating force can be expressed as follows:

$$\text{Accelerated force} = \text{factor} \times \text{R. P. M.}^2 \times r \times M,$$

where r = radius of crank in feet,
M = mass of reciprocating parts.

The factor is dependent upon ratio of connecting rod length to crank length and angle of rotation, and is simply the reduction of the rather involved analytical expression. This has been published in "Dynamics of Machinery," by G. Lanza (p. 53), from which the following values are taken:

Crank Angles.	Ratio of Connecting-rod to Crank 4½:1.	Crank Angles.	Ratio of Connecting-rod to Crank of 4½:1
0:360	0.01340	120:240	0.00670
30:330	0.01075	150-210	0.00825
60:300	0.00427	180:180	0.00853
90:270	0.00250		

Considering the reciprocating parts for each cylinder as weighing 1½ tons, or 3,360 pounds, then the accelerating force at the top dead center is

$$(0.01340 - 0.00250) \times 140^2 \times \frac{39}{12 \times 2} \times \frac{3{,}360}{32.2} = 36{,}200 \text{ lbs.}$$

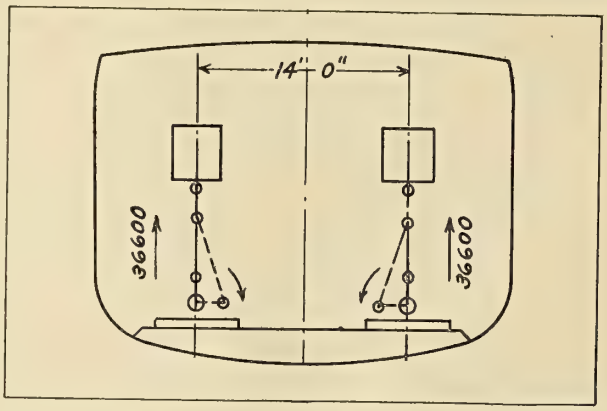
Similarly for the bottom center the accelerating force is

$$(0.00853 + 0.00250) \times 140^2 \times \frac{39}{12 \times 2} \times \frac{3{,}360}{32.2} = 36{,}600 \text{ lbs.}$$

These include the accelerating force along the line of dead points of the cylinder, whose crank is at 90 degrees from the one at dead point.

If the two engines get in step the total lifting force will be $2 \times 36{,}200 = 72{,}400$ pounds, and the depressing force will be $2 \times 36{,}600 = 73{,}200$ pounds.

If the engines were in step, but with one just at the top dead center when the other was at the bottom dead center,



Action of Vertical Free Force

there would be a heeling moment of $73{,}000 \times 14 = 1{,}022{,}000$ foot pounds.

Attention should be called to the fact that while the above gives a correct estimation of the magnitude of these forces in their actual operation, they are of but extremely brief duration and reverse their direction twice each revolution, so that their effect cannot be compared to the effect produced by a steady force of the same magnitude.

Books on Marine Engine Design

Q.—I am writing to see if you can help me on some work I am doing. I am a student at ———— and am specializing in marine work. I have a triple expansion marine engine of 2,500 horsepower to design, and up to date I have been unable to get hold of any design in any way similar to the one I am making. I wonder if you can send me any specifications and blueprints which would be of any service to me, or if this is not possible, tell me where I could get hold of such a design. Also can you tell me of any other good book beside Seaton's Manual which I could use. R. L.

A.—"Computations for Marine Engines," by C. H. Peabody, published by John Wiley & Sons, will give you just the information asked for. This takes up the complete design of a triple-expansion marine engine of 2,500 indicated horsepower of the standard merchant type. Seaton & Rounthwaite's "Pocket-book of Marine Engineering Rules and Tables," new (12th) edition, is a better book than Seaton's Manual for your needs.

Shipbuilding and General Marine News

Contracts for New Ships—Marine Terminal Improvements—Recent Launchings—Improved Appliances—Personal Items

The sale of the fifteen million dollar plant of the New York Shipbuilding Company, Camden, N. J., to the American International Corporation, the International Mercantile Marine Company, W. R. Grace & Company and the Pacific Mail Steamship Company was ratified at a special meeting of the stockholders of the New York Shipbuilding Company on November 27. The present officers of the company will not be changed. The company now has contracts which will fill the present capacity of the yard through 1917, but improvements and extensions are planned which will materially increase the capacity of the yard. Government work will be undertaken by the company, if offered, although the demands for the renewals of the fleets of the new owners, together with private business now on hand and in contemplation, it is expected will use the entire capacity of the yard and its extensions for the next five years.

The International Mercantile Marine now has fourteen ships under construction aggregating over a quarter of a million gross tons and is planning for the construction of four turbine passenger ships of about 32,000 gross tons each and of 25 knots speed for the American Line. It is expected that the Pacific Mail Steamship Company will soon place contracts for several large vessels and the Grace Company is also in the market for new tonnage.

Tentative negotiations are also understood to be under way for the merger of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., and the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. Although two large steel companies have been mentioned in connection with these negotiations, this rumor has been denied.

Ten Months of American Shipbuilding

The Bureau of Navigation, Department of Commerce, reports 968 sailing, steam, gas and unrigged vessels of 405,894 gross tons built in the United States and officially numbered during the ten months of the calendar year 1916. Of these, 76, aggregating 274,843 tons, were steel steamships. In addition to the above there were built for foreigners 36 wooden vessels of 372 gross tons and 11 steel vessels of 25,418 tons.

During the month of October 108 vessels of 54,029 gross tons were built, 12 of which were steel steamships, aggregating 31,785 gross tons.

Progress of American Shipbuilding

Steel merchant vessels building or under contract to be built in private American shipyards on November 1, 1916, according to builders' returns to the Bureau of Navigation, Department of Commerce, number 417, of 1,479,946 gross tons, an increase of 25,676 tons over the returns for October 1. During October American yards finished 17 steel merchant vessels of 52,491 gross tons, and made new contracts for 17 steel merchant vessels of 77,877 gross tons.

Shipbuilders in the United States expect to launch 314 vessels of 960,899 gross tons during the current fiscal year, and 103 vessels of 519,947 gross tons during the fiscal year ending June 30, 1918.

To build the naval vessels authorized in this year's naval programme, bids for which are now being considered by the Navy Department, a total of about 167,000 tons of steel will be required.

Marine engine and repair plants in the Pacific Northwest are experiencing a remarkably prosperous season, some of the larger plants are running both day and night shifts.

Fifty-three wooden vessels designed for the lumber traffic are now in course of construction in Oregon, Washington and British Columbia. In the construction of these vessels approximately 106,000,000 feet of lumber will be used, and when completed the vessels will have a combined lumber-carrying capacity of 79,500,000 feet.

Shipbuilding Notes

The building programme of the Bethlehem Steel Company, South Bethlehem, Pa., for vessels for its own use in bringing iron ore from Chile, Cuba and other countries, calls for the construction of twenty-five steamships of about 17,000 gross tons each. The company already has five steamships under construction at the Maryland Steel plant and more keels will be laid as launching ways can be spared.

The Ocean Steamship Company, known as the Savannah Line, W. H. Pleasants, president, Pier 35, North River, New York, is in the market for several more vessels. This company is already building two splendid passenger ships at the Harlan & Hollingsworth yard, Wilmington, Del.

An official of the Atlantic Gulf & West Indies Steamship Company, H. H. Raymond, general manager, Pier 30, North River, New York, is reported by the best of authority to have stated that his company is in the market for a large number of vessels, aggregating about fifty, if prices and time of delivery can be agreed upon.

The American Shipbuilding Company, Warrenton, Ore., Harry B. Spear, president, has received contracts to build six wooden motor ships, each to have a capacity of 2,000,000 feet of lumber.

The Anderson Steamboat Company, Seattle, Wash., has received a contract to build two 8,800-ton ships for Hannevig & Johnsen, New York.

The Wallace Shipyards, North Vancouver, B. C., have received contracts to build two steel steamships.

John Coughland & Sons, Vancouver, B. C., have a contract to build one steel steamship.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has given a contract to the McAteer Shipbuilding Company, Seattle, Wash., to build the first four sections of its 20,000-ton floating drydock.

The Seaborn Shipyards, Tacoma, Wash., are reported to have contracts on hand to construct wooden vessels to cost more than $1,000,000.

The Grays Harbor Shipyards, Aberdeen, Wash., have received contracts to build six lumber schooners to be equipped with Diesel engines.

The Seattle Construction & Dry Dock Company, Seattle, Wash., has recently received a contract for an 8,000-ton steel freighter for Barber & Company, New York.

Shipyard Notes

The Texas Company, 17 Battery Place, New York, is planning to build a dry dock and machine shop at Bath, Me.

J. F. Duthie & Son, Seattle, Wash., will greatly enlarge their shipbuilding plant at Seattle.

The Newburgh Shipbuilding Company, Newburg, N. Y., F. N. Bain, president, has awarded a contract for several buildings.

The Government of the Republic of Chile, South America, will build a very complete navy yard. Commander Julio Dittborn, naval attache, Chilean Embassy, Washington, D. C., has requested MARINE ENGINEERING to send this information to all concerns interested in furnishing navy yard supplies and equipment. All letters must be very complete, giving full information regarding equipment, together with prices, time of delivery, etc.

The Shipbuilding Joint Stock Company, "Noblessner," of Petrograd, Russia, asks MARINE ENGINEERING to request firms engaged in the manufacture of articles of ship equipment or goods and machinery relating to the shipbuilding business to send their catalogues or publications in duplicate, stating the name and address of their representative in Russia or elsewhere to whom inquiries should be addressed. Communications should be addressed to Shipbuilding Joint Stock Com-

pany, "Noblessner," Petrograd (Russia), Sampsonievsky quay 3.

It is reported that William Cornfoot, of the Albina Machine Works, Portland, Ore., will build a shipyard in connection with his plant, and that he has secured contracts to build two 3,300-ton steel steamships.

The Oregon Shipbuilding Company, Portland, Ore., has been incorporated by Carlton E. Spencer, George E. Hobson and C. A. Sheppherd. The new company has already received contracts to build four 8,800-ton steel freight ships for Norwegian interests.

Work has been begun on the shipbuilding yards of the Anderson-Seilzik Shipbuilding Company, Seattle, Wash., and the company is stated to have received contracts to build two 9,000-ton freight steamships for Norwegian interests.

The Pusey & Jones Company, Wilmington, Del., is placing large orders for equipment for new shops which it has erected.

The Buffalo Dry Dock Company will build a two-story reinforced concrete warehouse and shop at its plant in Buffalo.

A shipyard is being constructed at Tsurumi, on Tokyo Bay, north of Yokohama, Japan, for the president of one of the large Japanese steamship companies. The area of the yard will be about 115 acres, and four shipways will be provided for building ships of 10,000 tons.

The Seattle Construction & Dry Dock Company, Seattle, Wash., is about to distribute 300 shares of its stock, now earning 7 percent, among its yard employees, and, in addition, will distribute 450 and 500 shares among its executive staff and office force.

The Bethlehem Steel Company has awarded contracts for a large number of cranes required at its Maryland Steel Company plant, Sparrows Point, Md. The Morgan Engineering Company and the Alliance Machine Company, both of Alliance, Ohio, were the successful bidders.

On October 20 announcement was made of the taking over by the State of Massachusetts of land on both sides of Hayward's Creek at Quincy, Mass., 150 acres of which will be developed by the Commonwealth for steamship and railroad terminals. A portion of this land not required by the Commonwealth for this development will be leased for a long term of years to the Fore River Shipbuilding Corporation, which intends to erect building slips, shops, etc., for accommodating new work. These additional building facilities will allow for an extensive expansion of the Fore River yard.

The Albina Engine & Machine Works, Portland, Ore., is negotiating for several contracts for steel steamers of 8,000 tons or more capacity, and is planning to enlarge its yard to meet the demands for new construction.

A controlling interest in the McEachern-Standifer-Clarkson Ship Company, of Astoria, Ore., has been purchased by A. O. Anderson & Company, Ltd., of Copenhagen, incorporated in the States of Oregon and New York. Guy M. Standifer and James Clarkson, Astoria, will retire from the company and devote their interests to the Standifer-Clarkson shipyard on North Portland harbor. The McEachern yard, situated on Young's Bay, is now building several auxiliary schooners of the five-masted type.

Recent Launchings

The Baltimore Dry Docks & Shipbuilding Company, Baltimore, Md., launched on October 28 the oil tanker *Homer Evans*, 306 feet long by 47 feet beam by 28 feet depth, of 3,500 gross tons, for Hannevig & Johnsen, New York.

The Seattle Construction & Dry Dock Company, Seattle, Wash., launched on October 21 the 6,000-ton steel freighter *Panuco* for the *Ward Line*.

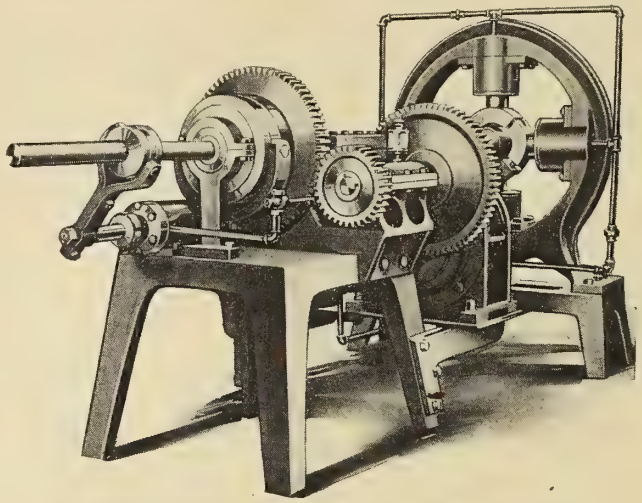
The Union Iron Works, San Francisco, Cal., launched on October 24 the tank steamer *H. C. Folger* for the Atlantic Refining Company.

The New York Shipbuilding Company, Camden, N. J., recently launched the tank steamer *Royal Arrow*, 475 feet long, 62.3 feet beam and 39.6 feet depth, for the Standard Transportation Company, New York. The *Royal Arrow* has a carrying capacity of 4,000,000 gallons. Propulsion is by triple-expansion engines, supplied by Scotch boilers designed to give the vessel a speed of 10½ or 11 knots.

A comprehensive project for the remodeling of all the leading navy yards in the United States and the creation of two completely equipped naval bases, involving an expenditure of from $50,000,000 (£10,250,000) to $100,000,000 (£20,500,000), has been laid before Congress in formal recommendations submitted to the House Committee on Naval Affairs by Rear-Admiral Harris, Chief of the Bureau of Yards and Docks.

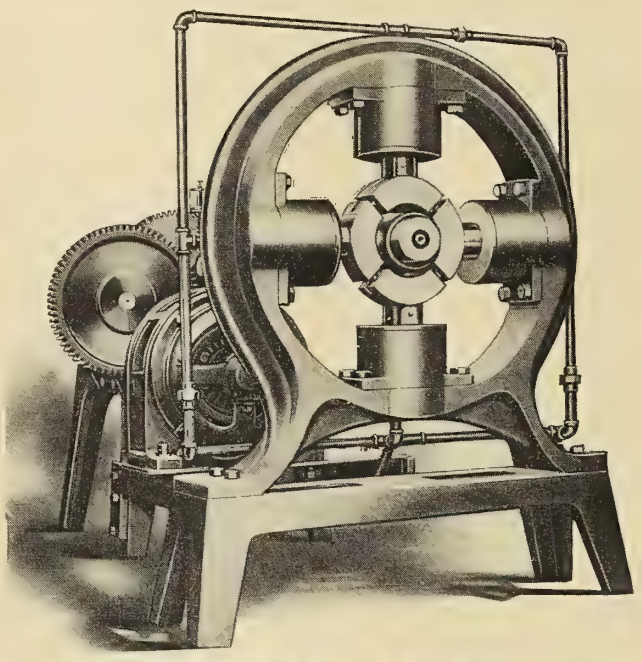
Universal Flue Welder

The Southwark universal flue welder, manufactured by the Southwark Foundry & Machine Company, Philadelphia, Pa., is built sufficiently heavy to perform the welding of the large flues, and takes safe ends of lengths greater than the limits of the ordinary types of welder. A special device allows the working of the weld on the inside instead of on the outside



Driving Mechanism at Back of Universal Flue Welder

of the tube. The clamping head at the front and the driving mechanism at the back are the two main parts of the machine. The clamping head is made from one circular-shape casting, four air cylinders being mounted on the inside. The pistons are fitted with metal snap rings, instead of the ordinary cup leather type. The front end of the piston rods are equipped



Clamping Head at Front of Flue Welder

with sectional dies. These clamp the outside of the flue at the line of weld.

Piped up to a single air line the cylinders operate simultaneously with the opening of the valve. Running through the center of this head longitudinally with the machine is the welding mandrel which fits the inside of the flue.

Four rollers are assembled in the body of this mandrel, which is hollow. Tapered and free in their bearings, they can be moved radially by inserting a taper mandrel that reaches through the middle of the spindle from the back of the machine. This mandrel is operated by an air cylinder, also controlled by the main foot valve. The main mandrel is driven through two gear reductions to a 1½-horsepower motor.

An adjustable platform in front of the welder head, which supports the welding furnace, permits the proper location for different lengths of safe ends.

A cast iron tank or water back protects the welding head from excessive heat from the furnace. The size of the mandrel, back of the welding rollers, approximates the inside diameter of the flue. This supports the weight of the safe end while being heated and moved to the welding position, which prevents any loss due to the dropping off of safe ends, as frequently occurs.

Naval Architecture to be Taught at George Washington University

A course of instruction in naval architecture, covering a period of one year, has been established at the George Washington University, Washington, D. C. Rear-Admiral Charles H. Stockton, president of the University, and Dean Howard L. Hodgkin, of the College of Engineering, are considering the advisability of introducing a complete four-year course in marine engineering and naval architecture. The proximity of the George Washington University to numerous large shipbuilding plants, the naval model basin and the offices of the Navy Department, it is believed, render it ideally situated for such work. The fact that studies may be taken evenings permits enrollment of students otherwise employed during the day. Arthur F. Johnson, M. E., is instructor in charge of the work in naval architecture.

Motor Tank Ship Bramell Point Sails on Her Maiden Voyage

The motor-driven oil tanker *Bramell Point*, the first American commercial motor-driven ship ever built, arrived in New York harbor on November 9 from Baltimore, Md., after a satisfactory trial trip. The *Bramell Point* is owned by the Vacuum Oil Company, of 61 Broadway, New York.

The vessel was launched at Baltimore July 1. She has a capacity of 5,000 tons, is 293 feet long, 47 feet beam and has a depth of 28 feet. Her three Bolinder oil engines develop 1,650 horsepower.

She flies the American flag, is manned by a crew of 28 American seamen, and is in command of Capt. Andrew Munkowitz.

After loading a cargo of refined oil at Bayonne the *Bramell Point* sailed for Lisbon, Portugal, on her maiden trip. It is expected that the round-trip will consume about 30 days' time. On her return to New York she will be continued in overseas trade.

Puget Sound Branch of American Society of Marine Draftsmen Holds Its First Annual Banquet

On Saturday evening, October 14, fifty-three members and guests of the Puget Sound Branch of the American Society of Marine Draftsmen, gathered together at the Hotel Butler in Seattle, Wash., for the first annual banquet of this branch of the society. Before the banquet the members met in one of the spacious meeting rooms of the hotel and the business of the society was discussed.

The toastmaster for the evening was Mr. A. F. Reeves, who spoke, in part, of the obect of the society, and of the urgent need for maintaining a high standard of efficiency among the members, so that the name of the society would not only act as a title, but carry with it a high standard of proficiency which would be looked upon with esteem by all.

Mr. D. G. Smith, president of this branch, pointed to the fact that heretofore when ships were built to fill the demand and against keen competition, and positions were not easily obtained, the draftsmen worked as individuals, but now that shipbuilding has become an enterprise involving great prosperity, the draftsmen should work in the strength and unity which the present time affords, and to be willing to offer their brains and skill to the country when necessity arises.

Reference was made by Mr. E. F. Maas to the proposed joint study classes and lectures, and to the club house and reference library to be established for the benefit of the members.

Other speakers of the evening were Mr. R. M. Semmes, president of the Alaska Pacific Navigation Company, who expressed his belief that shipbuilding will steadily progress in this country after the war; and Mr. J. H. Todd and W. C. Nickum, both of the Seattle Construction & Dry Dock Company, pledged their support to the organization, and pointed to facts to show the importance of draftsmen to the shipyard arganization and the responsibilities which they assume.

PERSONAL

ROBERT C. MILLER has been appointed purchasing agent of the Staten Island Shipbuilding Company, New York, succeeding W. H. Moore, retired.

JAMES DONALD, a well-known marine engineer and naval architect, formerly practising in London, has been appointed general manager of the States Marine & Commercial Company, Inc., ship and insurance brokers, steamship forwarding and general agents, with offices at 17 Battery Place, New York.

EDMUND VICTOR TELFER, an apprentice in the service of Messrs. William Gray & Company, Ltd., West Hartlepool, has been awarded the 1916 scholarship of the North East Coast Institution of Engineers and Shipbuilders, Newcastle-upon-Tyne.

H. F. ALEXANDER, of Tacoma, Wash., who twenty-two years ago was a 'longshoreman on the Tacoma docks, is now at the age of 37, head of the Pacific Steamship Company, the largest coastwise steamship company on the Pacific.

CHARLES H. POTTER, formerly general manager of the Luckenbach Steamship Company, New York, is president of the Potter Transportation Company, Inc., and vice-president of C. W. Chadwick & Company, both of New York.

PAUL H. COOP, who is well-known in engineering circles on the Pacific Coast, has been appointed representative of the Eckliff Automatic Boiler Circulator Company, with offices in the Hobart building, San Francisco, Cal.

OBITUARY

CHARLES BOOTH, chairman of the Booth Steamship Company, died on November 23 in London, aged 56.

THOMAS BARNETT MILLER, for many years a member of the shipbuilding and ship repair firm of Alexander Miller & Bros., Jersey City, N. J., died on November 8 in Brooklyn, N. Y., aged 52 years.

JAMES C. WALLACE, president of the American Shipbuilding Company from 1905 to 1914, died at his home in Cleveland, Ohio, on October 31, aged 52. Since retiring from the shipbuilding firm Mr. Wallace has devoted himself to vessel interests on the Great Lakes.

WILLIAM J. BURLEE, president of the Staten Island Shipbuilding Company, West New Brighton, N. Y., died on November 7 at his home in Port Richmond, N. Y., aged 55. Mr. Burlee organized the Staten Island Shipbuilding Company in 1898, and was president of it up to the time of his death.

CAPTAIN HOWARD PATTERSON, instructor, lecturer and author on nautical astronomy and theoretical navigation, and founder of the New York Navigation School, died on September 1 at his home in Brooklyn, N. Y., aged 61. Captain Patterson acted as private tutor on nautical subjects to many prominent yachtsmen in the United States.

CAPTAIN JAMES MCALLISTER, founder of the old Greenpoint Lighterage Company, which has since been merged into the firm of McAllister Bros., and controls more than 100 boats in the lighterage business of New York harbor, died recently at his home in Brooklyn. At the time of his death Mr. McAllister was general manager of McAllister Bros., and also president and general manager of the McAllister Dry Dock & Shipyard Company, Port Richmond, Staten Island.

EDWARD THOMAS HENDEE, secretary of Joseph T. Ryerson & Son, Chicago, died in Minneapolis, Minn., on November 12, aged 36. Mr. Hendee became associated with Joseph T. Ryerson & Son in 1902 as advertising manager, later becoming manager of the machinery department. In 1911 he was made assistant to the president, and in 1913 assumed charge of the railway supply department, while later in the year he was elected secretary of the company.

CORRECTION.—The statement on page 485 of our November issue, to the effect that the new plate and angle shop at the Fore River Shipyard is said to be the largest shop of its kind in the world appears to be erroneous, as the floor area of this shop is approximately 144,450 square feet, as against a floor area of 152,860 square feet for the plate and angle shop of the New York Shipbuilding Company, Camden, N. J.

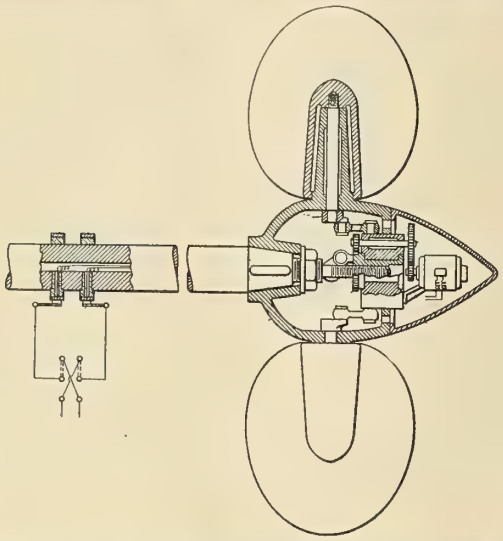
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,181,458. REVERSIBLE SCREW PROPELLER. ANATOL DAVID ISKOLS, OF SCHENECTADY, N. Y.

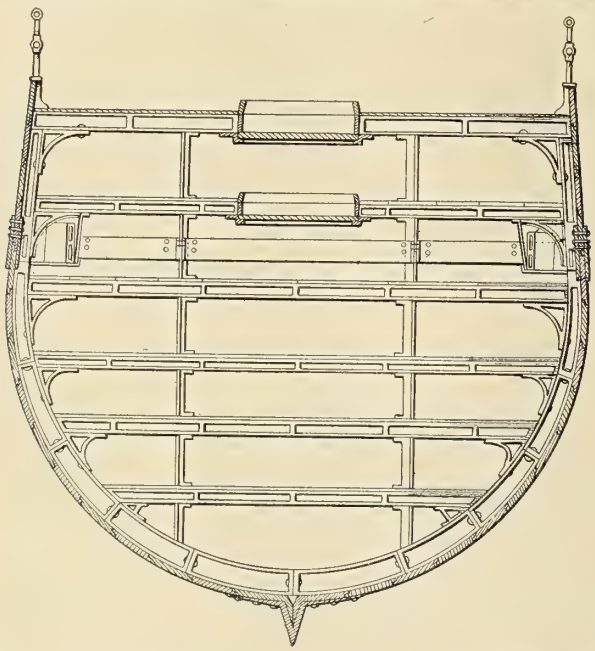
Claim 1.—In a reversible screw propeller, the combination of a hub having stands projecting outwardly therefrom to substantially the center of hydraulic pressure region of the blades, blades mounted thereon



and arranged to be angularly adjusted, each blade being supported on a stand at substantially its center of hydraulic pressure region, spindles that are supported by the stands, each of which is attached to a blade, and means located within the hub for turning the spindles and blades.

1,184,564. SECTIONAL HULL FOR SHIPS. JESSE E. OGDEN, OF EAST AUBURN, CAL.

Claim 1.—A hull for vessels, including a lower hull section having ribs, an upper hull section having ribs, the ribs of one section engaging



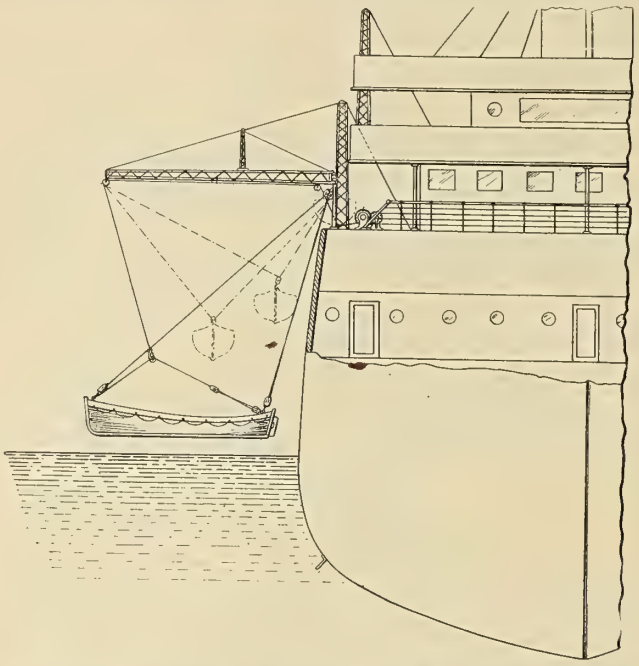
at their ends with the corresponding ribs of the other section, the ends of the ribs of one section being slotted to receive reduced ends of the ribs of the other section and the interlocking portions of the ribs being further slotted, and wedges driven through the slots of the rib sections to connect the ribs. Six claims.

1,197,666. ELASTIC FLUID TURBINE. RICHARD H. RICE, OF LYNN, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—The combination with an elastic fluid turbine, of a source of superheated elastic fluid, a conduit for conveying elastic fluid from it to the turbine, a regulating valve in such conduit, a source of elastic fluid of a lower temperature, a second conduit for conveying elastic fluid from it to the first named conduit, said second conduit connecting with the first named conduit in advance of the regulating valve, a valve in the second conduit, a thermostat which is subjected to the temperature of the exhaust from the turbine, and means controlled by the thermostat for positioning the valve in the second conduit. Five claims.

1,152,678. LAUNCHING APPARATUS FOR BOATS. SIGFRID NELSON WESSBERG, OF BROOKLYN, N. Y.

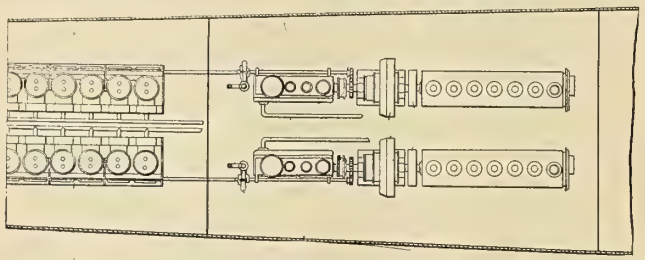
Claim 1.—A launching apparatus comprising a derrick located between tiers of boats on the deck of a ship and having a swinging boom adapted to extend beyond the ship's side more than the length of the boat to be launched, a lowering tackle on said boom, davits for supporting the boats, davit blocks and tackle connected with said davits and adapted to be connected with the boat, a boat hung on said davit blocks, a detachable span connected to each end of said boat and provided with



means midway its length for connection with the lowering tackle on the boom, one end of said span including a block and tackle whereby said end may be lengthened while the boat is being lowered. Five claims.

1,200,997. PROPELLING APPARATUS FOR VESSELS. LAWRENCE YORK SPEAR, OF GROTON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

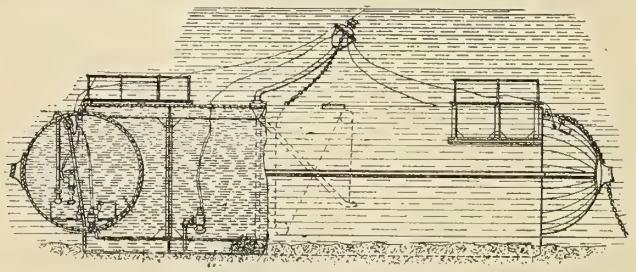
Claim 1.—In a vessel, propelling apparatus comprising the combination of a propeller shaft, a main engine, means for connecting the engine to and disconnecting it from the shaft, a dynamo-electric machine



adapted to drive the shaft, a second engine, a dynamo-electric machine driven by the last named dynamo-electric machine when the latter is operating as a motor, and electric connections between the two machines for operating either as a generator and the other as a motor. Six claims.

1,201,051. SUBMERSIBLE STORAGE TANK. CHARLES PETER MITCHELL JACK, OF BROOKLYN, N. Y.

Claim 1.—An elongated cylindrical balanced pressure tank for the storage of oil, adapted to be floated or submerged at will, in combina-



tion with valve and pipe connections for receiving and discharging oil, a delivery pipe connected thereto, and a buoy for supporting the delivery pipe to the valve-controlling device. Six claims.

1,201,737. RELEASING DEVICE. CHARLES HUNT, OF NEW YORK, N. Y.

Claim 1.—A releasing device for launching mechanism, comprising a holding bar, a locking lever co-operating with the holding bar to hold the launching tackle, a latch for supporting the locking lever, a supporting lever for the latch, a tripping dog for actuating the supporting lever, and means for actuating the tripping dog. Five claims.

TRADE PUBLICATIONS

"Flowkote" enamel, which is claimed to be especially valuable for use on board ship, is the subject of a circular issued by Harrison Bros. & Company, Philadelphia, Pa. "Supreme refinement and excellence of finish is obtained with this new white enamel—'Flowkote.' The unusual qualities of 'Flowkote' have placed it in the foreground for flowing qualities and great durability. Equally high-class effects secured on outdoor or indoor work; never checks or cracks. Not to be confused with the so-called quick-drying enamels."

Compasses and other nautical instruments are the subject of a catalogue issued by the Marine Compass Company, Bryantville, Mass. One of the instruments described and illustrated in this catalogue is the Cole course protractor, which is stated to be in use on many large vessels and to be highly endorsed by experienced navigators. The catalogue gives the following description of this instrument: "An unlimited number of courses may be taken without resetting the instrument. Variation and deviation are applied automatically. Allowances for drift and current may be made. No sliding is necessary as with the ordinary parallel rulers, and it will work equally well on a damp or wet chart. It will be found especially valuable in working a vessel in strange waters, entering harbors, or working up a coast where many courses and bearings are necessary to be taken at interrupted intervals. It enables the navigator to recognize or identify new landmarks, and in windward work enables a vessel to beat through, with confidence, passages that are otherwise difficult to navigate. The instrument is simple to operate. The rule is first placed on the compass rose or meridian lines on the chart, in some easily recognized direction, such as east and west; the dial is then turned by the thumb nut so that the reading directly under the two small pointers is also east and west. The dial is to be kept in position by keeping the fingers pressed on the thumb nut. Any movement of, or the direction of any position of the rule is automatically shown by the two small pointers. Further directions on how to use the protractor is sent with each instrument. The instrument is made of polished brass, finely lacquered. The dial base is made of heavy gage brass, and has a circle of rubber on the under side to prevent slipping. The instrument is furnished with a felt-lined mahogany case, and when cover is closed it is securely fastened in place."

"Electrify Every Ship on Your Line" is the advice given in a bulletin published by the General Electric Company, Schenectady, N. Y. "You will be surprised how much real protection and benefit electricity is on shipboard. Passengers and crew appreciate the good, bright light, and the electric fans and electric heaters are a distinct advertisement for your boats. G-E electric equipment on board ship will give the same continuous satisfactory service as the G-E generator in the big power plants ashore—they are built with the same knowledge, experience and reputation behind them."

Hoists for use on docks and piers and in shipyards are described in a circular which has just been published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. "We manufacture standard overhead electric traveling cranes, grab-bucket overhead electric traveling cranes, transfer overhead electric traveling cranes, jib and bracket cranes, portable electric hoists, standard cage operated monorail hoists, back-geared electric motors, T-bar current conductors, I-beam switches, trolleys, 'Shepard' double monorail track. We build these machines in a large variety of types and sizes, which constitute a complete line of hoisting equipment, in capacities of 500 pounds to 60,000 pounds."

The Southwark Gross Press for reclaiming scrap material and repairing steel cars, is described in a circular just issued by the Southwark Foundry & Machine Company, 400 Washington avenue, Philadelphia, Pa. "The rapid and almost universal adoption of all-steel equipment in railroad rolling stock created the need for a powerful press to be used in reclaiming from the scrap heap bent and damaged parts of wrecked cars, and in promoting the various other functions of the repair shop for which the older press equipment adapted to the needs of wooden cars proved inadequate. The development of the Southwark Gross Press is therefore an important step toward the solution of many railroad shop problems, and it has become a valuable and very necessary part of repair shop equipment. Its usefulness, however, is by no means confined to the railroad, as the demand for presses of increased capacity up to the standard of the Southwark Gross Press has been growing steadily in every branch of the iron and steel industries. The field for this press is almost universal, and some idea of its adaptability to the needs of general manufacturing and repair shop work may be had from a study of the accompanying illustrations and descriptive matter."

HIGHER SUPERHEAT MEANS GREATER ECONOMY

As the degree of **superheat increases** the rate of **coal saving increases.**

Condensation appears in the cylinders when **superheat disappears.**

For the most economical operation superheat is therefore essential in every cylinder, and can only be obtained by high initial steam temperatures.

The accompanying table which was presented by Mr. Harry Gray before the Institution of Naval Architects shows that 180° of superheat is not enough to provide superheated steam in the low pressure cylinder of a triple expansion engine; the same condition applies when made for a quadruple expansion engine and here 211° of superheat is not enough.

	S.S. "PORT AUGUSTA." Triple-Expansion Engines.				S.S. "PORT LINCOLN" AND "PORT MACQUARIE" Quadruple-Expansion Engines.			
STEAM CHEST.	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.	Gauge pressure in steam chests.	Temp. due to steam pressure.	Temp. recorded.	Degree of superheat.
	lbs.	Deg. F.	Deg. F.	Deg. F.	lbs.	Deg. F.	Deg. F.	Deg. F.
High Pressure	160	370	550	180	206	389	600	+211
1st Intermediate	53	300	400	100	97	335	460	+125
2d Intermediate	—	—	—	—	38	284	290	+ 6
Low Pressure	10	240	?	?	9	237	220	

Our fire tube superheaters are capable of furnishing an initial superheat high enough to permit the completion of the expansion in all cylinders without condensation.

Our latest bulletin shows how the savings of 12 to 20% in fuel may be made available for your ships.

Where shall we mail your copy?

LOCOMOTIVE SUPERHEATER COMPANY

New York MARINE SUPERHEATERS Chicago

Smooth-On Instruction Book No. 16, published by the Smooth-On Manufacturing Company, Jersey City, N. J., contains much information every mechanic should know. A copy will be sent free to any of our readers upon request. This book describes and illustrates actual repairs of steam and water leaks in castings, pipings, boilers, etc., that saved thousands of dollars and many hours of time.

"Advice and Comments on Many Problems and Information About Brushes" is the title of a profusely illustrated booklet of 88 pages, which has just been issued by the John L. Whiting-J. J. Adams Company, 690 Harrison avenue, Boston, Mass. The Whiting-Adams Company makes a large variety of brushes which are especially adapted to marine use—both on board ship and for use in painting docks, wharves and warehouses. A copy of this book will be sent to any of our readers, free upon request.

The Marten-Freeman compensating davit is described in an illustrated folder published by the Steward Davit & Equipment Corporation, 17 Battery Place, New York. "The Marten-Freeman compensating davit complies in every way with the requirements of the Seaman's Act, and is one of the few types that is passed without question by inspectors of the United States Steamboat Inspection Service. It will put a lifeboat from inboard to outboard position, ready for lowering, in 30 seconds, under most unfavorable conditions of list and sea. The leading American shipbuilding companies are installing Marten-Freeman compensating davits, among them being Fore River Ship Building Corporation, Maryland Steel Company, Newport News Ship Building & Dry Dock Company, William Cramp & Sons Ship & Engine Building Company. Many of the steamship lines have installed Marten-Freeman davits on existing and on new ships, among them being the Southern Pacific Company, Munson Line, Eastern Steamship Corporation, Peninsula & Occidental Steamship Company, Lukenback Steamship Company, American Hawaiian Steamship Company, Cuba Distilling Company, Texas Company, New York & South America Line. These installations are being made on freight and passenger ships. Marine engineers, naval architects and all those familiar with requirements of a davit comment favorably upon and approve of the mechanical construction and efficiency of the Marten-Freeman davit."

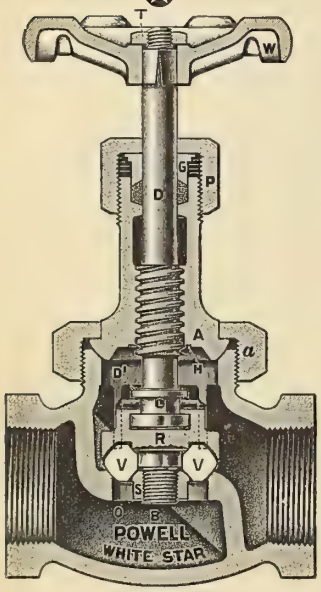
"Vapor-Tight" piston rings are described in a circular published by the Baker Valve Company, Minneapolis, Minn. "Much waste in engines comes from poor piston rings. Common snap rings cannot be kept tight. 'Vapor-Tight' rings when properly placed cannot leak. You will at once recognize the merits of the 'Vapor-Tight' ring and its advantages over other types. Notice the one-piece wearing surface, which eliminates all chance of scoring on account of loose couplers, segments or pins. The inner ring is so designed that it will always keep the split of the outer ring sealed. This means full power and fuel economy. When used in automobiles, gas and oil tractors 'Vapor-Tight' rings reduce carbonization to the minimum. Try a set of 'Vapor-Tight' rings in your motor and note the favorable results."

Vertical self-oiling engines are described in illustrated Bulletin No. 300, published by Engberg's Electric & Mechanical Works, 5 Vine street, St. Joseph, Mich. "Engberg engines and dynamos, direct connected, have been on the market for a period of approximately eighteen years. This service certainly requires a strictly first-class engine, an engine that is dependable, even when operating under most exacting conditions. However, owing to the constant demand we have had for engines for driving blowers, stokers, pumps, ash-handling equipment, etc., we have decided to also specialize on engine work only, because we can see the trade demands an engine of undisputable merits and something that will give continuous, efficient and dependable service. Going into this descriptive bulletin, you will see in Engberg engines nothing has been spared which would add to successful operation. Furthermore, you will find they have been most carefully and painstakingly designed on good, sound engineering principles. You will find the very best material for the purpose, while the general design throughout is positively unexcelled, as our many years of experience in the building of vertical, self-oiling engines enables us to know exactly what the trade demands, and we have made these engines with the idea in view of reducing complication; that is, simplifying construction in a general way as well as details, and still not sacrificing anything which would add to successful operation. These engines are constructed by the most modern methods, special designed tools being used to insure perfect workmanship throughout. We invite most careful inspection as well as investigation, because the general principles, as well as the smallest details, have never failed to attract the attention of the most critical buyer."

"White Star" Booklet on Request.

POWELL VALVES

(Especially The "White Star" Valve)



MR. ENGINEER:—

Here Are Five Good Reasons Why You Should Use Powell Valves Especially the "White Star" Valve

Because	First	A good salesman may make a first sale to you, but after that POWELL VALVES require little salesmanship.
Because	Second	POWELL VALVES sell themselves—they always make good on your pipe lines.
Because	Third	The Engineer who installs POWELL VALVES, especially the "White Star" Valve, eliminates all his valve troubles.
Because	Fourth	Engineers find our claims for POWELL VALVES to be as represented in our catalogue.
Because	Fifth	The world-wide demand for POWELL VALVES, Especially the "White Star" Valve, is based on superior quality, workmanship, and satisfactory results.

ASK YOUR DEALER FOR POWELL "WHITE STAR" VALVES OR WRITE US.

THE WM. POWELL CO.

DEPENDABLE ENGINEERING SPECIALTIES.

CINCINNATI, O.

When writing to advertisers, please mention INTERNATIONAL MARINE ENGINEERING.

FATHER TIME INQUIRED

"How do you explain the remarkable fact that "for smokestacks, winches, anchors and all exposed metal and wood work above and below "the decks Dixon's Silica-Graphite Paint lasts "longer, and therefore costs less per year of "service, than any other protective paint."

MOTHER NATURE REPLIED:

"Because Dixon's Silica-Graphite Paint is not "a mechanical mixture of the silica and graphite. "It is Nature's mixture of the flake silica-"graphite, mined only by the Dixon Company "at an American Mine and used by them with "the highest grade of pure, boiled linseed oil "for over fifty years as their unrivalled paint "film. The Dixon Company also performs its "part. It makes no secondary grade. It "grinds the flakes to great fineness so that the "film will be adhesive."

Send for Booklet No. 75-B.

Made in Jersey City, N. J., by the

JOSEPH DIXON CRUCIBLE CO.

ESTABLISHED 1827

B-133

A reversible ratchet wrench is described in a catalogue published by Greene, Tweed & Company, 109 Duane street, New York. This wrench works with a quick, straight-ahead ratchet movement without lost motion. It has a socket form of head that encompasses the nut on all sides with equal bearing. It is claimed that slipping, which injures the nut, is impossible when this wrench is used.

The K-G torch is shown cutting through three steel-copper alloy plates, each plate ¾ inch thick and riveted together, in a picture in a catalogue just issued by the K-G Welding & Cutting Company, 556 West Thirty-fourth street, New York. "Start made without drilling hole or beginning at edge. Try this with your torch. How much gas and labor do you waste with imperfectly cutting torches?"

"The Right Way" is the title of a folder issued by the Leavitt Machine Company, Orange, Mass. There are two pictures in this circular. One illustrates the "old way" of repairing a steam valve, which took two men, and which consisted in removing the valve and putting in a new one, this operation costing from a few dollars to $50, or even more. The picture of the "right way" shows one man with a Dexter machine repairing a 3-inch valve in position, the operation taking only 10 to 15 minutes and the expense being trivial.

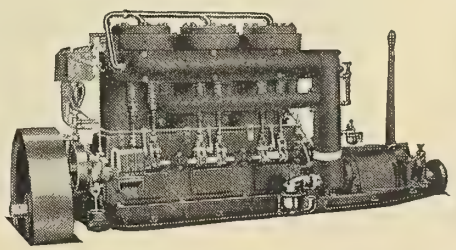
"Higher Superheat Means Greater Economy." This is the title of a bulletin published by the Locomotive Superheater Company, 30 Church street, New York. "As the degree of superheat increases the rate of coal saving increases. Condensation appears in the cylinders when superheat disappears. For the most economical operation superheat is therefore essential in every cylinder, and can only be obtained by high initial steam temperatures." An accompanying table, which was presented by Mr. Harry Gray before the Institution of Naval Architects, shows that 180 degrees of superheat is not enough to provide superheated steam in the low-pressure cylinder of a triple-expansion engine; the same condition applies when made for a quadruple expansion engine, and here 211 degrees of superheat is not enough. "Our firetube superheaters are capable of furnishing an initial superheat high enough to permit the completion of the expansion in all cylinders without condensation. Our latest bulletin shows how the savings of 12 to 20 percent in fuel may be made available for your ships. Where shall we mail your copy?"

Steam turbines and reduction gears are described in an illustrated catalogue just issued by the Moore Steam Turbine Corporation, Wellsville, N. Y. "The organizers and managers of the Moore Steam Turbine Corporation have had long experience in the design and manufacture of steam turbines, and there are embodied in the design of the Moore steam turbine the latest and best ideas in steam turbine construction known to the art. The Moore steam turbine has been developed to meet a demand for a highly efficient steam turbine in sizes from 5 to 1,000 horsepower. Designers and users of steam turbines have recognized for some years past that the most efficient type of steam turbine is what has come to be known as a combination type; that is, one type of turbine is used for the high-pressure part of the expansion, combined with another type for the low-pressure stages. A familiar example of this is the combination of a single velocity stage for the high-pressure element with Parsons or Rateau stages for the low pressure. The Moore single stage turbine consists of a single velocity stage, made up of a set of diverging expanding nozzles and a wheel carrying two rows of moving blades, with a set of stationary reversing vanes following the first row of moving blades. The single-stage steam turbine is the oldest type. Machines of this type were formerly built in this country in small sizes at speeds from 7,500 to 20,000 revolutions per minute, with reduction gears for reducing the speeds. This design was abandoned on account of an excessive amount of trouble with the gears and on account of the high rotation stresses, which were the cause of frequent and serious accidents, resulting in buckets being thrown out of the wheel, and in some instances rupture of the wheel itself. Notwithstanding this failure of the single-wheel type at excessive speeds, another manufacturer has recently brought out a turbine running at speeds up to 7,200 revolutions. A number of failures of wheels at this speed have already occurred, and the evidence points to what we believe will prove to be a fact, namely, that 7,200 revolutions is an excessive speed for any size of steam turbine. The policy of the Moore Steam Turbine Corporation will be to limit the speeds of our large turbines to 3,600 revolutions per minute, and of the smaller sizes to 5,000 revolutions per minute as a maximum, and to obtain the required steam consumption by multi-staging if necessary. By this means the rotation stresses will be kept at a low figure, affording a larger margin of safety, a very important feature, and one which should not be lost sight of by the prospective purchaser."

WOLVERINE for MARINE SERVICE

THE MOTOR WITH THE BORE and STROKE

FUELS { KEROSENE (PARAFFIN) GASOLINE (PETROL) DISTILLATE SUCTION PRODUCER GAS



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